NASA

Aerospace Medicine and Biology

A Continuing Bibliography with Indexes

NASA SP-7011 (342)
November 1990

National Aeronautics and Space Administration

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Aerospace Medicine and Biology

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

STAR (N-10000 Series)	N90-25072 — N90-26789
IAA (A-10000 Series)	A90-42520 — A90-45844

NASA SP-7011(342)

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 342)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in October 1990 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Division
Washington, DC 1990

This supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, price code A05.

INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 208 reports, articles and other documents announced during October 1990 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).* The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR,* including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1990 Supplements.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

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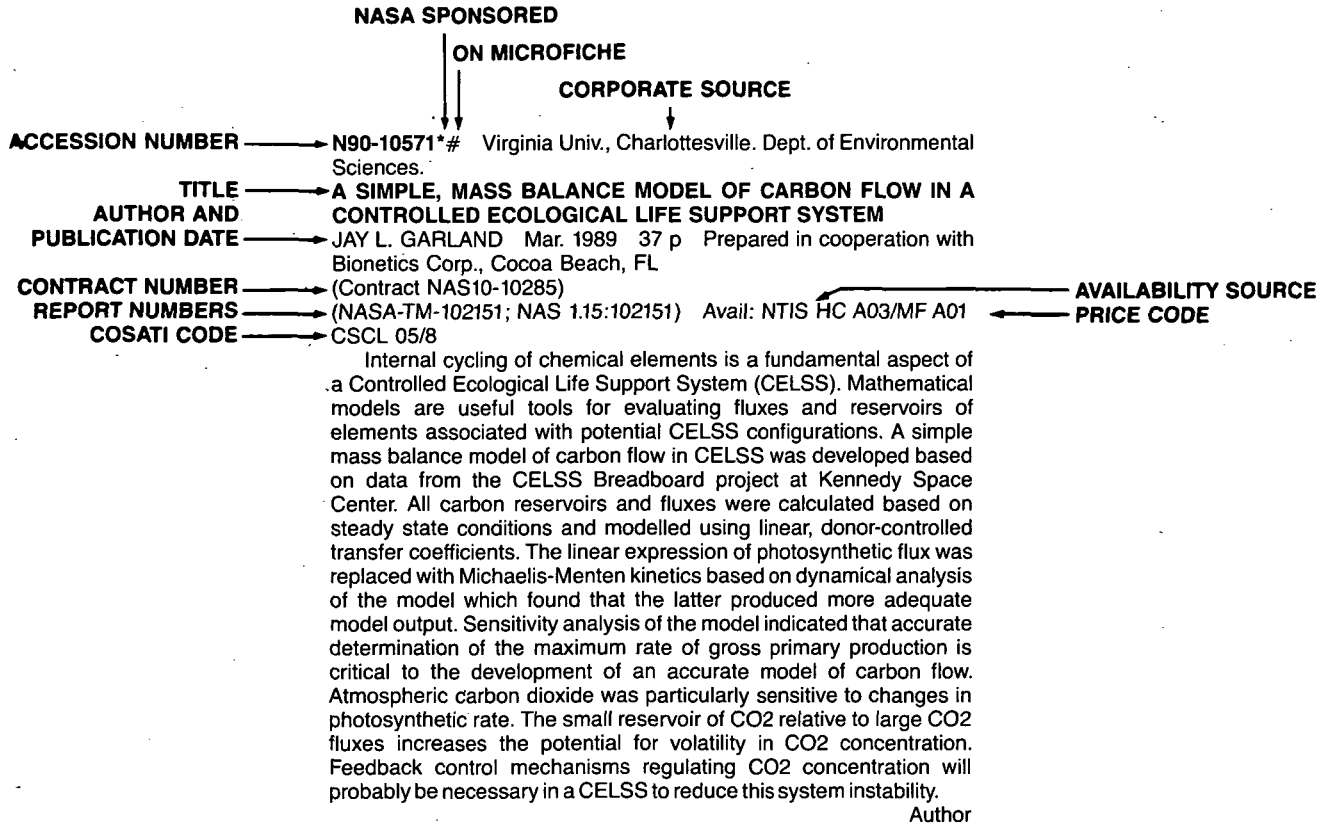
TYPICAL REPORT CITATION AND ABSTRACT



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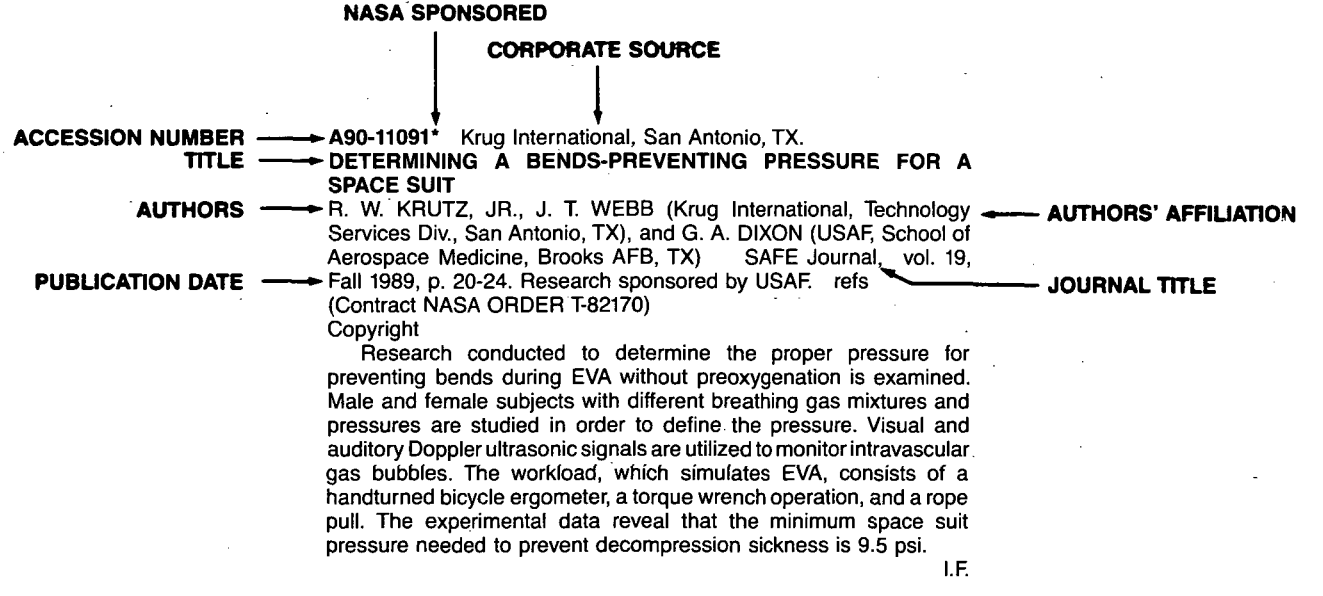

AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 342)

NOVEMBER 1990

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LIFE SCIENCES (GENERAL)

A90-43369
DNH DEOXYRIBONUCLEOHELICATES - SELF ASSEMBLY OF OLIGONUCLEOSIDIC DOUBLE-HELICAL METAL COMPLEXES
ULRICH KOERT, MARGARET M. HARDING, and JEAN-MARIE LEHN (Strasbourg I, Universite, France) Nature (ISSN 0028-0836), vol. 346, July 26, 1990, p. 339-342. Research supported by CNRS, Fonds der Chemischen Industrie, and College de France. refs
Copyright

A class of artificial systems called the nucleohelicates is presented which combine the double helical structure of the double-stranded metal complexes called helicate with the selective interaction features of nucleic-acid bases. These functionalized species allow the study of structural effects on the formation of the double helix and on binding to other entities, in particular to nucleic acids. C.D.

A90-43457#
RESPONSES OF RATS TO 3-WEEK CENTRIFUGAL ACCELERATIONS
MASAMICHI SUDOH and SACHIO IKAWA (Tokyo Jikeikai University, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, Sept. 1988, p. 69-74. In Japanese, with abstract in English. refs

The effects of gravity on physiological changes in rats exposed to three-week centrifugal accelerations are studied. Twelve female rats are exposed to 1 G, 1.6 G or 3 G. Body weight, urine volume, food and water intake, and water balance are measured and analyzed. The data reveal that body weight and daily food and water intake decrease due to acute exposure to hypergravity, and that gravity intensity affects the rate of the decrease. I.F.

A90-43458#
CHANGES OF BLOOD CELLS AFTER HYPER-GRAVITY EXPOSURE
SHINJI WAKAMATSU, ISAMU SUGIE, TADASHI OKADA, YOSHIHIRO NAKAMURA, TAKASHI MORISHITA (Aichi Medical University, Japan) et al. Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, Sept. 1988, p. 75-83. In Japanese, with abstract in English. refs

The effects of 2 G, 3 G, and 10 G exposure on blood cells are examined. The erythrocytes, platelets, leukocytes, corpuscular hemoglobin, erythropoietin, and eosinophiles of male hamsters are analyzed. It is observed that exposure to 10 G causes a decrease in leukocyte counts, but does not influence erythrocyte and platelet counts. The data reveal (1) that hypergravity does not affect hemoglobin; (2) that it causes variable changes in the frequency size distribution of erythrocytes; and (3) that blood erythropoietin concentrations and eosinophiles decrease. The size of platelets and collagen-induced platelet aggregration increase due to hypergravity, and 10 G exposure results in deformation of the platelets. I.F.

A90-43459#
THE MITOCHONDRIAL VOLUME AND FIBER TYPE TRANSITION OF SKELETAL MUSCLE AFTER SUSPENSION HYPOKINESIA IN RAT
TOSHITADA YOSHIOKA, HISASHI SAIKI (Saint Marianna University, Kawasaki, Japan), HIROAKI TAKEKURA, and YOSHINOBU OHIRA (National Institute of Fitness and Sports, Kanoya, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, Dec. 1988, p. 87-96. In Japanese, with abstract in English. refs

The effects of hypokinesia on the structural and biochemical properties of the slow and fast skeletal muscles and of three types of muscle fibers were investigated in rats subjected to body-suspension hypokinesia. The analyses of oxidative- and glycolitic-enzyme activities were performed in slow and fast muscles (the soleus and the extensor digitorum longus, respectively) from suspended rats and in electrically stimulated muscles. It was found that a 15-day-long suspension led to decreases in activities of succinate dehydrogenase and malate dehydrogenase in the soleus, which did not return to the initial level even after the stimulation by 50 Hz. The activities of lactate dehydrogenase and phosphofructokinase of the extensor digitorum longus (but not of the soleus) also decreased. Both the suspended and the stimulated muscles exhibited degenerative features, such as myofibrillar disruption and enlarged extracellular spaces. I.S.

A90-43480
LIFE SCIENCES STRATEGY
HARRY C. HOLLOWAY (Uniformed Services University of the Health Sciences, Bethesda, MD) IN: The 21st century in space; Proceedings of the Thirty-fifth Annual AAS Conference, Saint Louis, MO, Oct. 24-26, 1988. San Diego, CA, Univelt, Inc., 1990, p. 335-345.
(AAS PAPER 88-227) Copyright

NASA's life sciences strategy is discussed. The way that the priority programs are developed and promoted in government is examined. The positioning of the various life sciences programs within the NASA organization itself is discussed. C.D.

A90-43481
LIFE SCIENCES ROLE IN SYSTEMS ENGINEERING OF SPACE PROGRAMS
WILLIAM C. SCHNEIDER (Development Computer Sciences Corp., Silver Sring, MD) IN: The 21st century in space; Proceedings of the Thirty-fifth Annual AAS Conference, Saint Louis, MO, Oct. 24-26, 1988. San Diego, CA, Univelt, Inc., 1990, p. 347-350.
(AAS PAPER 88-228) Copyright

The role of life science experimentation in determining the systems engineering of spacecraft is briefly addressed. The effect of life science findings on the design of life support systems is emphasized. The problem of acclimating living bodies to a long-term existence in a low-gravity environment is discussed. C.D.

A90-44250
DIFFERENTIAL INTERACTION OF CHIRAL BETA-PARTICLES WITH ENANTIOMERS
A. S. GARAY and J. A. AHLGREN-BECKENDORF (Texas A & M University, College Station) Nature (ISSN 0028-0836), vol. 346, Aug. 2, 1990, p. 451-453. Research supported by Texas Agricultural

Experiment Station and CNRS. refs
Copyright

Pulse-height spectroscopy was used to examine the Cerenkov radiation emitted as beta-particles pass through liquid chiral enantiomers. The results show that helical electrons do distinguish between molecules of opposite chirality, complementing results reported in earlier publications in which differential decay, positron annihilation, scattering, or other interactions were observed. C.D.

A90-44274* Medical Coll. of Wisconsin, Milwaukee.
RAT LIMB UNLOADING - SOLEUS HISTOCHEMISTRY, ULTRASTRUCTURE, AND ELECTROMYOGRAPHY
D. A. RILEY, G. R. SLOCUM, J. L. W. BAIN, F. R. SEDLAK, T. E. SOWA (Wisconsin, Medical College, Milwaukee) et al. Journal of Applied Physiology (ISSN 0161-7567), vol. 69, July 1990, p. 58-66. refs
(Contract NAG2-460; NAG2-552)
Copyright

The effects of hindlimb unloading on rat-soleus histochemisty, ultrastructure, and electromyogram (EMG) activity were investigated. It was found that, after 14 days of tail suspension, the area of type I and type IIa muscle fibers decreased by 63 and 47 percent, respectively, mainly due to the degradation of subsarcolemmal mitochondria and myofibrils. After 10 days, 3 percent of type IIa fibers exhibited segmental necrosis. After four days, video monitoring revealed abnormal plantar flexion of the hindfeet, which shortened the soleus working range. The EMG activity shifted from tonic to phasic, and aggregate activity decreased drastically after only seven days. The results indictate that the pathological changes in the soleus resulted from unloaded contractions, reduced use, compromised blood flow, and shortened working length. I.S.

A90-44577#
STUDY OF BRAIN SUPRA-SLOW ENCEPHALOFLUCTUOGRAPH OF RABBIT DURING SIMULATED WEIGHTLESSNESS
XIANYUN SHEN (Institute of Aerospace Medico-Engineering, Beijing, People's Republic of China) et al. Chinese Space Science and Technology (ISSN 1000-758X), vol. 9, Aug. 1989, p. 59-65. In Chinese, with abstract in English. refs

The changes of brain supraslow encephalofluctuograph of a rabbit were significant during head-down 20 deg suspension for 15 days. Some of 16 spectra sections, the structures of S1-S8 spectra, the S spectra harmonic oscillation, and the power ratio were changed. These changes indicate the brain function of the rabbit was influenced by the suspension. The result showed that the brain supraslow encephalofluctuograph technology can be used to study the brain function of astronauts during weightlessness.
Author

A90-44776#
THERMOREGULATORY RESPONSES TO +3GZ IN RATS AT DIFFERENT TIME OF DAY
YOSHIAKI ISOBE, TOSHIKO MAKINO, and KOKICHI OHARA (Nagoya City University, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 26, Sept. 1989, p. 65-71. refs

To determine the thermoregulatory mechanism in a hypergravitational field, rats were exposed to +3Gz (achieved by centrifugation) for 15 minutes, and the responses of their skin (tail) and body (rectal) temperatures were studied. Prior to +3Gz exposure, diurnal changes of skin and body temperatures of the test animals were examined as control. Then the response to +3Gz at 24 C was compared in the same animal during different time of day - 21:00 (dark) and 09:00 (light). Decrease in body temperature was greater during the light period than during the dark period, while increase in skin temperature was smaller during the light than during the dark. The thermoregulatory mechanism during different times of the day at +3Gz (non-thermal stress) is found to be the same as that for thermal stress. Author

N90-25453*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CARBON DIOXIDE AND WATER EXCHANGE RATES BY A WHEAT CROP IN NASA'S BIOMASS PRODUCTION CHAMBER: RESULTS FROM AN 86-DAY STUDY (JANUARY TO APRIL 1989)
R. M. WHEELER (Bionetics Corp., Cocoa Beach, FL.) and J. C. SAGER Jan. 1990 30 p
(NASA-TM-102788; NAS 1.15:102788) Avail: NTIS HC A03/MF A01 CSCL 06C

Gas exchange measurements were taken for a 20 sq m wheat stand grown from seed to harvest in NASA's Biomass Production Chamber. Respiration of the wheat stand caused the CO2 concentrations to rise an average of 440 ppm during the 4-h dark period each day, or 7.2 umol/sq m/sec. Dark period respiration was sensitive to temperature changes and could be increased 70 to 75 percent by raising the temperature from 16 C to 24 C. Stand photosynthesis (measured from the rate of CO2 drawdown immediately after the lights came on each day) peaked at 27 umol/sq m/sec at 25 days after planting and averaged 15 umol/sq m/sec throughout the study. By combining the average light period photosynthesis and average dark period respiration, a net of 860 g or 470 liters of CO2 were fixed per day. Stand photosynthetic rates showed a linear increase with increasing irradiance (750 umol/sq m/sec PPF the highest level tested), with an average light compensation point after day 30 of 190 umol/sq m/sec. Stand photosynthesis decreased slightly when CO2 levels were decreased from 2200 to 800 ppm, but dropped sharply when CO2 was decreased below 700 to 800 ppm. Water production from stand transpiration peaked at 120 L/day near 25 days and averaged about 90 L/day, or 4.5 L/sq m/day throughout the study. Author

N90-25454# Southwest Foundation for Biomedical Research, San Antonio, TX.
PROGRAM REVIEW: THE LIFETIME EFFECTS OF SPACE RADIATION IN RHESUS MONKEYS Final Report, Mar. - Jul. 1989
THOMAS M. BUTLER Mar. 1990 29 p
(Contract F33615-87-D-0627; AF PROJ. 7757)
(AD-A221127; USAFSAM-TR-90-3) Avail: NTIS HC A03/MF A01 CSCL 06/18

Findings are summarized from a select panel of scientists charged with reviewing the quality and productivity of the USAFSAM 24-year in-house study of the lifetime effects of space radiation in the rhesus monkey. The panel also had the responsibility of assessing the value of the study in both military and civilian scientific applications and making recommendations for maximizing the yield of relevant data as the animals near the end of their life span. The panelists reviewed results presented by project scientists during a 2-day conference. They were unanimous in their endorsement of the study as a uniquely important resource of information on the late effects of space radiation and the interaction of late effects with the normal aging process. In asserting that the study should be continued for at least another 5 years, the panel made specific recommendations for additional work to be carried out in collaboration with scientists at other laboratories who could provide the breadth of technical expertise required to fully exploit the potential of this project. The scientific proceedings of the conference will be published as separate journal articles.
GRA

N90-25455*# Bionetics Corp., Cocoa Beach, FL.
UTILIZATION OF THE WATER SOLUABLE FRACTION OF WHEAT STRAW AS A PLANT NUTRIENT SOURCE
C. L. MACKOWIAK and J. L. GARLAND (Virginia Univ., Charlottesville.) Jun. 1990 27 p
(Contract NAS10-11624)
(NASA-TM-103497; NAS 1.15:103497) Avail: NTIS HC A03/MF A01 CSCL 06/3

Recovery of water soluble, inorganic nutrients from the inedible portion of wheat was found to be an effective means of recycling nutrients within hydroponic systems. Through aqueous extraction (leaching), 60 percent of the total inorganic nutrient weight was

removed from wheat straw and roots, although the recovery of individual nutrients varied. Leaching also removed about 20 percent of the total organic carbon from the biomass. In terms of dry weight, the leachate was comprised of approximately 60 percent organic and 40 percent inorganic compounds. Direct use of wheat straw leachate in static hydroponic systems had an inhibitory effect on wheat growth, both in the presence and absence of microorganisms. Biological treatment of leachate either with a mixed microbial community or the oyster mushroom Pleurotus ostreatus L., prior to use in hydroponic solutions, significantly reduced both the organic content and the inhibitory effects of the leachate. The inhibitory effects of unprocessed leachate appear to be a result of rapidly acting phytotoxic compounds that are detoxified by microbial activity. Leaching holds considerable promise as a method for nutrient recycling in a Controlled Ecological Life Support System (CELSS). Author

N90-25456*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
SYSTEM DEVELOPMENT AND EARLY BIOLOGICAL TESTS IN NASA'S BIOMASS PRODUCTION CHAMBER
R. M. WHEELER, C. L. MACKOWIAK, T. W. DRESCHEL, J. C. SAGER, R. P. PRINCE, W. M. KNOTT, C. R. HINKLE, and R. F. STRAYER (Bionetics Corp., Cocoa Beach, FL.) Mar. 1990 30 p
(NASA-TM-103494; NAS 1.15:103494) Avail: NTIS HC A03/MF A01 CSCL 06/3

The Biomass Production Chamber at Kennedy Space Center was constructed to conduct large scale plant growth studies for NASA's CELSS program. Over the past four years, physical systems and computer control software have been continually upgraded and the degree of atmospheric leakage from the chamber has decreased from about 40 to 5 percent of the total volume per day. Early tests conducted with a limited degree of closure showed that total crop (wheat) growth from the best trays was within 80 percent of reported optimal yields for similar light levels. Yields from subsequent tests under more tightly closed conditions have not been as good--up to only 65 percent of optimal yields. Yields appear to have decreased with increasing closure, yet potential problems exist in cultural techniques and further studies are warranted. With the ability to tightly seal the chamber, quantitative data were gathered on CO2 and water exchange rates. Results showed that stand photosynthesis and transpiration reached a peak near 25 days after planting, soon after full vegetative ground cover was established. In the final phase of testing when atmospheric closure was the highest, ethylene gas levels in the chamber rose from about 10 to nearly 120 ppb. Evidence suggests that the ethylene originated from the wheat plants themselves and may have caused an epinastic rolling of the leaves, but no apparent detrimental effects on whole plant function. Author

N90-25457* Lockheed Engineering and Sciences Co., Washington, DC.
USSR SPACE LIFE SCIENCES DIGEST, ISSUE 27
LYDIA RAZRAN STONE, ed., RONALD TEETER, ed., VICTORIA GARSHNEK, ed., and JOSEPH ROWE, ed. (Library of Congress, Washington, DC.) Washington NASA Jul. 1990 87 p
(Contract NASW-4292)
(NASA-CR-3922(32); NAS 1.26:3922(32)) Avail: NTIS HC A06/MF A01 CSCL 06/2

This is the twenty-fifth issue of NASA's Space Life Sciences Digest. It contains abstracts of 30 journal papers or book chapters published in Russian and of 2 Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. The abstracts in this issue have been identified as relevant to 18 areas of space biology and medicine. These areas include: adaptation, aviation medicine, biological rhythms, biospherics, botany, cardiovascular and respiratory systems, endocrinology, enzymology, exobiology, habitability and environmental effects, hematology, immunology, metabolism, musculoskeletal system, neurophysiology, radiobiology, and space medicine. A Soviet book review of a British handbook of aviation medicine and a description of the work of the division on aviation and space medicine of the Moscow Physiological Society are also included. Author

N90-25458*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ECUT: ENERGY CONVERSION AND UTILIZATION TECHNOLOGIES PROGRAM. BIOCATALYSIS PROJECT Annual Report, FY 1989
May 1990 85 p Prepared in cooperation with Department of Energy, Washington, DC
(Contract NAS7-918; DE-A101-86CE-90239)
(NASA-CR-186866; NAS 1.26:186866; DOE/CS-66001/13)
Avail: NTIS HC A05/MF A01 CSCL 06/2

The Biocatalysis Project is a mission-oriented, applied research and exploratory development activity directed toward resolution of the major generic technical barriers that impede the development of biologically catalyzed commercial chemical production. The approach toward achieving project objectives involves an integrated participation of Universities, Industrial Companies and Government Research Laboratories. The Project's technical activities were organized into three work elements: molecular modeling and applied genetics; bioprocess engineering; and bioprocess design and assessment. Author

N90-26452*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE US EXPERIMENTS FLOWN ON THE SOVIET BIOSATELLITE COSMOS 1887 Final Reports
JAMES P. CONNOLLY, ed., RICHARD E. GRINDELAND, ed., and RODNEY W. BALLARD, ed. Feb. 1990 501 p
(NASA-TM-102254; A-90013; NAS 1.15:102254) Avail: NTIS HC A22/MF A03 CSCL 06/3

Cosmos 1887, a biosatellite containing biological and radiation experiments from the Soviet Union, the United States and seven other countries, was launched on September 29, 1987. One Rhesus monkey's feeder stopped working two days into the flight and a decision was made to terminate the mission after 12 1/2 days. The biosatellite returned to Earth on October 12, 1987. A system malfunction, during the reentry procedure, caused the Cosmos 1887 spacecraft to land approximately 1800 miles beyond the intended landing site and delayed the start of the postflight procedures by approximately 44 hours. Further information on the conditions at landing and postflight activities is included in the Mission Operations portion of this document. U.S. and U.S.S.R. specialists jointly conducted 26 experiments on this mission, including the postflight transfer of data, hardware and biosamples to the U.S.

N90-26453*# Medical Coll. of Wisconsin, Milwaukee. Dept. of Anatomy and Cellular Biology.
EFFECTS OF MICROGRAVITY ON RAT MUSCLE
D. A. RILEY *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 45-49 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

It is well known that humans exposed to long term spaceflight experience undesirable progressive muscle weakness and increased fatigability. This problem has prompted the implementation of inflight exercise programs because most investigators believe that the major cause of diminished muscle performance is a combination of disuse and decreased workload. Inflight exercise has improved muscle health, but deficits have persisted, indicating that either the regimens utilized were suboptimal or there existed additional debilitating factors which were not remedied by exercise. Clarification of this question requires an improved understanding of the cellular and molecular basis of spaceflight-induced muscle deterioration. To this end, multiple investigations have been performed on the muscles from rats orbited 5 to 22 days in Cosmos biosatellites and Spacelab-3 (2,4,5,8,10 to 14,16,18,19,21 to 23,25,27,28). The eight Cosmos 1887 investigations examined the structural and biochemical changes in skeletal and cardiac muscles of rats exposed to microgravity for 12.5 days and returned to terrestrial gravity 2.3

days before tissues were collected. Even though interpretation of these results was complicated by the combination of inflight and postflight induced alterations, the consensus is that there is marked heterogeneity in both degree and type of responses from the whole muscle level down to the molecular level. Collectively, the muscle investigations of Cosmos 1887 clearly illustrate the wide diversity of muscle tissue responses to spaceflight. Judging from the summary report of this mission, heterogeneity of responses is not unique to muscle tissue. Elucidating the mechanism underlying this heterogeneity holds the key to explaining adaptation of the organism to prolonged spaceflight. Author

N90-26454*# Columbia Univ., New York, NY. School of Oral and Dental Surgery.

EFFECTS OF MICROGRAVITY ON RAT BONE, CARTLAGE AND CONNECTIVE TISSUES

S. DOTY *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 51-56 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

The response to hypogravity by the skeletal system was originally thought to be the result of a reduction in weight bearing. Thus a reduced rate of new bone formation in the weight-bearing bones was accepted, when found, as an obvious result of hypogravity. However, data on non-weight-bearing tissues have begun to show that other physiological changes can be expected to occur to animals during spaceflight. This overview of the Cosmos 1887 data discusses these results as they pertain to individual bones or tissues because the response seems to depend on the architecture and metabolism of each tissue under study. Various effects were seen in different tissues from the rats flown on Cosmos 1887. The femur showed a reduced bone mineral content but only in the central region of the diaphysis. This same region in the tibia showed changes in the vascularity of bone as well as some osteocytic cell death. The humerus demonstrated reduced morphometric characteristics plus a decrease in mechanical stiffness. Bone mineral crystals did not mature normally as a result of flight, suggesting a defect in the matrix mineralization process. Note that these changes relate directly to the matrix portion of the bone or some function of bone which slowly responds to changes in the environment. However, most cellular functions of bone are rapid responders. The stimulation of osteoblast precursor cells, the osteoblast function in collagen synthesis, a change in the proliferation rate of cells in the epiphyseal growth plate, the synthesis and secretion of osteocalcin, and the movement of water into or out of tissues, are all processes which respond to environmental change. These rapidly responding events produced results from Cosmos 1887 which were frequently quite different from previous space flight data. Author

N90-26455*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENT K-6-01. DISTRIBUTION AND BIOCHEMISTRY OF MINERAL AND MATRIX IN THE FEMURS OF RATS

S. ARNAUD, G. MECHANIC, P. BUCKENDAHL, T. BROMAGE, A. BOYDE, J. ELLIOTT, E. KATZ, and G DURNOVA (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 63-84 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Previous analyses of the composition of mineral and matrix in the bone of young rats following space flight has revealed deficits in calcium, phosphorus, and osteocalcin, a non-collagenous protein, without an associated decrease in collagen. To characterize the location and nature of this mineralization defect in a weight bearing long bone, the femur, researchers attempted to relate the spatial distribution of mineral in situ in the proximal, central and distal thirds of the femoral diaphysis to the biochemical composition of bone from the same area. Biochemical analyses revealed lower concentrations of calcium, phosphorus and osteocalcin but not collagen only in the central third of the diaphysis of the flight animals (F) compared to synchronous controls (S). Collagen concentration was reduced only in the proximal third of the diaphysis, where all 3 crosslinks, expressed as nM/mol collagen were higher in F than S. A new technique, x ray microtomography, with a resolution of 26 microns, was used to obtain semi-quantitative data on mineral distribution in reconstructed sections of wet whole bone. To improve the resolution of the mineral density distribution, images of the surfaces of cut sections were analyzed by backscattered electrons in a scanning electron microscope (BSE). There was good agreement between the results of the two stereochemical techniques which revealed distinct patterns of mineralization in transverse and longitudinal directions of the diaphysis. The novel methodology developed for this flight experiment shows considerable promise in elucidating the biochemical nature of what appear to be regional alterations in the mineralization of long bones of animals exposed to spaceflight. Author

N90-26456*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENT K-6-02. BIOMEDICAL, BIOCHEMICAL AND MORPHOLOGICAL ALTERATIONS OF MUSCLE AND DENSE, FIBROUS CONNECTIVE TISSUES DURING 14 DAYS OF SPACEFLIGHT

A. VAILAS, R. ZERNICKE, R. GRINDELAND, and A. KAPLANSKI (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 85-112 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Findings on the connective tissue response to short-term space flight (12 days) are discussed. Specifically, data regarding the biochemical, biomechanical and morphological characteristics of selected connective tissues (humerus, vertebral body, tendon and skeletal muscle) of growing rats is given. Results are given concerning the humerus cortical bone, the vertebral bone, nutritional effects on bone biomechanical properties, and soft tense fiber connective tissue response. Author

N90-26457*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENT K-6-03. GRAVITY AND SKELETAL GROWTH, PART 1. PART 2: MORPHOLOGY AND HISTOCHEMISTRY OF BONE CELLS AND VASCULATURE OF THE TIBIA; PART 3: NUCLEAR VOLUME ANALYSIS OF OSTEOBLAST HISTOGENESIS IN PERIODONTAL LIGAMENT CELLS; PART 4: INTERVERTEBRAL DISC SWELLING PRESSURE ASSOCIATED WITH MICROGRAVITY

E. HOLTON, A. HARGENS, M. GONSALVES, D. BERRETTA, S. DOTY, W. ROBERTS, L. GARETTO, A. KAPLANSKY, G. DURNOVA, S. GOTT (California Univ., San Diego.) et al. *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 113-149 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Bone area, bone electrophysiology, bone vascularity, osteoblast morphology, and osteoblast histogenesis were studied in rats associated with Cosmos 1887. The results suggest that the synchronous animals were the only group with a significantly larger bone area than the basal group, that the bone electrical potential was more negative in flight than in the synchronous rats, that the endosteal osteoblasts from flight rats had greater numbers of transitional Golgi vesicles but no difference in the large Golgi saccules or the alkaline phosphatase activity, that the perioteal vasculature in the shaft of flight rats often showed very dense intraluminal deposits with adjacent degenerating osteocytes as well as lipid accumulations within the lumen of the vessels and sometimes degeneration of the vascular wall (this change was not present in the metaphyseal region of flight animals), and that the progenitor cells decreased in flight rats while the preosteoblasts increased compared to controls. Many of the results suggest that the animals were beginning to recover from the effects of spaceflight during the two day interval between landing and euthanasia; flight effects, such as the vascular changes, did not appear to recover. Author

N90-26458*# California Univ., San Francisco. Dept. of Radiology.

EXPERIMENT K-6-04. TRACE ELEMENT BALANCE IN RATS DURING SPACEFLIGHT

C. E. CANN, P. PATTERSON-BUCKENDAHL, G. DURNOVA, and A. KAPLANSKY (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 151-155 Feb. 1990

Exposure to microgravity causes alterations in the skeletal and mineral homeostatic systems. Little is known about the effects of flight in an older skeleton; limited data suggest that bone resorption is increased after 5 days but no data are available about other metabolic effects. The response of a more slowly-growing skeleton to microgravity may be different than that of a younger animal, similar to the different responses seen in adolescents and adult humans to immobilization. This experiment was designed to investigate changes occurring in skeletal and mineral homeostatis in these older rats flown for two weeks in space. We may expect that the two portions of the rat vertebra, the vertebral body and the posterior elements, will show different responses to spaceflight. The results of the analyses from this study confirm major differences between portions of the vertebra. The posterior bone is more highly mineralized, evidenced by increased concentration (per unit weight of bone) of calcium (5 percent), phosphorus (6 percent) and osteocalcin (37 percent), similar to the differences seen between proximal and mid humerus in previous studies. The major increase in osteocalcin content indicates the presence of mature, low-turnover bone. The difference between flight and control animals were minimal in these older, slower-growing rats. Mass of whole vertebrae increased 6.2 percent in synchronous rats compared to less than 2 percent in flight rats over the 16 days when compared to basal controls, suggesting a decreased rate of bone growth in flight. Compared to young rats in which vertebral mass increased over 40 percent in 10 days in controls and 20 percent in flight rats, this may be a clear indication that even in the older skeleton bone growth will slow in microgravity. Author

N90-26459*# Texas Univ., Galveston. Dept. of Surgery.

EXPERIMENT K-6-05. THE MATURATON OF BONE AND DENTIN MATRICES IN RATS FLOWN ON COSMOS 1887

D. SIMMONS, M. GRYNPAS, G. ROSENBERG, and G. DURNOVA (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 157-168 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

The chemistry, hydroxyapatite crystal size, and maturation of the bone and dentin is characterized in rats exposed to microgravity for 12.5d in a Soviet Biosatellite (Cosmos-1887). Calvarial and vertebral bone ash was subnormal, but contained a normal percent composition of Ca, P, and Mg. These tissues varied from the norm by having lower Ca/P and higher Ca/Mg ratios than any of their age-matched controls (Vivarium and Synchronous Groups). Gradient density analyses (calvaria) indicated a strong shift to the lower sp.gr. fractions which was commensurate with impaired rates of matrix-mineral maturation. X-ray diffraction data were confirmatory. Bone hydroxyapatite crystal growth in Flight rats was preferentially altered in a way to reduce the dimension of their C-axis. Flight rat dentin was normal with respect to age-matched control Ca, P, Mg, and Zn concentrations and their Ca/P and Ca/Mg ratios. These observations affirm the concept that microgravity adversely affects the maturation of newly formed matrix and mineral moieties in bone. Author

N90-26460*# Texas Univ. Health Science Center, Houston.

EXPERIMENT K-6-06. MORPHOMETRIC AND EM ANALYSES OF TIBIAL EPIPHYSEAL PLATES FROM COSMOS 1887 RATS

P. J. DUKE, D. MONTUFAR-SOLIS, and G. DURNOVA (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 169-182 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Light and electron microscopy studies were carried out on decalcified tibial epiphyseal plates of rats flown aboard Cosmos 1887 (12.5d flight plus 53.5h recovery). Analysis of variance showed that the proliferative zone of flight animals was significantly higher than that of synchronous controls, while the hypertrophic/calcification zone was significantly reduced. Flight animals had more cells than synchronous controls in the proliferative zone, and less in the hypertrophic/calcification region. The total number of cells, however, was significantly higher in flight animals. No differences were found for perimeter or shape factor of growth plates, but area was significantly lower in flight animals in comparison to synchronous controls. Collagen fibrils in flight animals were shorter and wider than in synchronous controls. The time required for a cell to cycle through the growth plate is 2 to 3 days, so most of the cells and matrix present were formed after the animals had returned to 1 g, and probably represent stages of recovery from microgravity exposure, which in itself is an interesting question. Author

N90-26461*# California Univ., Los Angeles. Dept. of Kinesiology.

EXPERIMENT K-6-07. METABOLIC AND MORPHOLOGIC PROPERTIES OF MUSCLE FIBERS AFTER SPACEFLIGHT

R. EDGERTON, B. MIU, THOMAS P. MARTIN, R. ROY, J. MARINI, J. J. LEGER, V. OGANOV, and E. ILYINA-KAKUEVA (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 183-205 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

The present study demonstrates that the general capability of skeletal muscle to maintain its proteins decreases rapidly in response to space flight. The present findings suggest further that the magnitude of enzymatic and cell volumes changes in response to space flight depend on several factors including the muscle and its fiber type composition. It appears that in order to associate physiological relevance to the observed enzymatic changes, cell volume should be considered also. Although it remains unclear as to the stimulus, or lack of stimulus, that triggers the rapid changes in muscle proteins in response to space flight, ground-based models of muscle atrophy suggest that the reduction in mechanical loading of muscle may be more important than the total amount of activation over a 24-hr period. Author

N90-26462*# Louisville Univ., KY. Dept. of Physiology and Biophysics.

EXPERIMENT K-6-08. BIOCHEMICAL AND HISTOCHEMICAL OBSERVATIONS OF VASTUS MEDIALIS

X. J. MUSACCHIA, J. M. STEFFEN, R. D. FELL, and V. S. OGANOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 207-214 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Muscles of the hindlimb in the rat have been used to demonstrate the effects of unloading in weightlessness and in animal models used to mimic weightlessness. The vastus medialis (VM) is discussed here. Samples were obtained from rats exposed to weightlessness for 12 days in Cosmos 1887 (Experiment K-6-08, coordinated by Dr. V.S. Oganov). The principal objective of this study was to ascertain if the vastus medialis responded to 12 days of microgravity exposure. The loss in muscle mass is greatest, -43 percent, when comparing F vs B, and least, -13 percent, when comparing F vs. V. Taken at face value these differences may be misleading. Due to the variability of the muscle weight in the basal group, these muscle mass losses may be exaggerated. In terms of percent water, there were no differences between the flight and the control groups. In spite of the limited sample, researchers conclude that muscle mass changes in the VM are not significant. Although some of the morphological parameters suggest a small degree of atrophy in the vastus medialis, the biochemical analyses (protein, RNA and DNA) suggest that these may be minimal and functionally nonsignificant. The relatively similar CS and LDH activities of VM from F and various control groups, as well as the lack of difference in LPL activity between F and S

rats, suggests that there is little or no effect on the oxidative or glycolytic function of this muscle. Since the VM is chiefly a mixed fast twitch muscle, these metabolic indices of energy production are relatively unchanged. The results of VM studies are in agreement with previous observations of another type II fast twitch muscle, the EDL, from SL-3 rats which did not respond markedly to weightlessness and whole body suspension. Author

N90-26463*# Medical Coll. of Wisconsin, Milwaukee. Dept. of Anatomy and Cellular Biology.
EXPERIMENT K-6-09. MORPHOLOGICAL AND BIOCHEMICAL INVESTIGATION OF MICROGRAVITY-INDUCED NERVE AND MUSCLE BREAKDOWN. PART 1: INVESTIGATION OF NERVE AND MUSCLE BREAKDOWN DURING SPACEFLIGHT; PART 2: BIOCHEMICAL ANALYSIS OF EDL AND PLT MUSCLES
D. A. RILEY, S. ELLIS, J. BAIN, F. SEDLAK, G. SLOCUM, and V. OGANOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 215-261 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

The present findings on rat hindlimb muscles suggest that skeletal muscle weakness induced by prolonged spaceflight can result from a combination of muscle fiber atrophy, muscle fiber segmental necrosis, degeneration of motor nerve terminals and destruction of microcirculatory vessels. Damage was confined to the red adductor longus (AL) and soleus muscles. The midbelly region of the AL muscle had more segmental necrosis and edema than the ends. Macrophages and neutrophils were the major mononucleated cells infiltrating and phagocytosing the cellular debris. Toluidine blue-positive mast cells were significantly decreased in Flight AL muscles compared to controls; this indicated that degranulation of mast cells contributed to tissue edema. Increased ubiquitination of disrupted myofibrils may have promoted myofilament degradation. Overall, mitochondria content and SDH activity were normal, except for a decrease in the subsarcolemmal region. The myofibrillar ATPase activity shifted toward the fast type in the Flight AL muscles. Some of the pathological changes may have occurred or been exacerbated during the 2 day postflight period of readaptation to terrestrial gravity. While simple atrophy should be reversible by exercise, restoration of pathological changes depends upon complex processes of regeneration by stem cells. Initial signs of muscle and nerve fiber regeneration were detected. Even though regeneration proceeds on Earth, the space environment may inhibit repair and cause progressive irreversible deterioration during long term missions. Muscles obtained from Flight rats sacrificed immediately (within a few hours) after landing are needed to distinguish inflight changes from postflight readaptation. Author

N90-26464*# California Univ., Irvine. Dept. of Physiology and Biophysics.
EXPERIMENT K-6-10. EFFECTS OF ZERO GRAVITY ON MYOFIBRIL PROTEIN CONTENT AND ISOMYOSIN DISTRIBUTION IN RODENT SKELETAL MUSCLE
K. BALDWIN, R. HERRICK, and V. OGANOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 263-273 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

The purpose of this experiment was to investigate the effects of 12 days of zero gravity (0G) exposure (Cosmos 1887 Biosputnik) on the enzymatic properties, protein content, and isomyosin distribution of the myofibril fraction of the slow-twitch vastus intermedius (VI) and the fast-twitch vastus lateralis (VL) muscles of adult male rats. Measurements were obtained on three experimental groups (n=5 each group) designated as flight-group (FG), vivarium-control (VC), and synchronous-control (SC). Body weight of the FG was significantly lower than the two control groups (p less than 0.05). Compared to the two control groups, VI weight was lower by 23 percent (p less than 0.10); whereas no such reduction was observed for the VL muscle. Myofibril yields (mg protein/g of muscle) in the VI were 35 percent lower in the FG compared to the controls (p less than 0.05); whereas, no such pattern was apparent for the VL muscle. When myofibril yields were expressed on a muscle basis (mg/g x muscle weight), the loss of myofibril protein was more exaggerated and suggests that myofibril protein degradation is an early event in the muscle atrophy response to 0G. Analysis of myosin isoforms indicated that slow-myosin was the primary isoform lost in the calculated degradation of total myosin. No evidence of loss of the fast isomyosins was apparent for either muscle following space flight. Myofibril ATPase activity of the VI was increased in the FG compared to controls, which is consistent with the observation of preferential slow-myosin degradation. These data suggest that muscles containing a high percent of slow-twitch fibers undergo greater degrees of myofibril protein degradation than do muscles containing predominantly fast-twitch fibers in response to a relatively short period of 0G exposure, and the primary target appears to be the slow-myosin molecule. Author

N90-26465*# Texas Univ. Health Science Center, Houston. Dept. of Physiology and Cell Biology.
EXPERIMENT K-6-11. ACTIN MRNA AND CYTOCHROME C MRNA CONCENTRATIONS IN THE TRICEPTS BRACHIA MUSCLE OF RATS
F. W. BOOTH, P. R. MORRISON, D. B. THOMASON, and V. S. OGANOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 275-278 Feb. 1990 (Contract NAG2-239)
Avail: NTIS HC A22/MF A03 CSCL 06/3

It is well known that some skeletal muscles atrophy as a result of weightlessness (Steffen and Musacchia 1986) and as a result of hindlimb suspension (Tischler et al., 1985, Thomason et al., 1987). Because the content of protein is determined by the rates of protein synthesis and degradation, a decrease in protein synthesis rate, or an increase in the protein degradation, or changes in both could produce the atrophy. Indeed, an increased protein degradation (Tischler et al., 1985) and a decreased protein synthesis (Thomason et al., 1988) have been observed in skeletal muscles of suspended hindlimbs of rats. Any decrease in protein synthesis rate could be caused by decreases in mRNA concentrations. Such decreases in the concentration and content of alpha-actin mRNA and cytochrome c mRNA have been noted in skeletal muscles of hindlimb suspended rats (Babij and Booth, 1988). From these findings researchers hypothesized that alpha-actin mRNA and cytochrome c mRNA would decrease in the triceps brachia muscle of Cosmos 1887 rats. Author

N90-26466*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENT K-6-12. MORPHOMETRIC STUDIES OF ATRIAL OR GRANULES AND HEPATOCYTES. PART 1: MORPHOMETRIC STUDY OF THE LIVER; PART 2: THE ATRIAL GRANULAR ACCUMULATIONS
L. M. KRAFT, L. C. KEIL, and I. A. POPOVA (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 279-296 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

The livers of flight, F, rats from the Cosmos 1887 mission were markedly paler and heavier than those of the synchronous, S, and vivarium, V, controls. In the F group, microscopic study revealed extensive hepatocytic intracytoplasmic vacuolization which was moderate in the S and minimal in the V groups. The vacuoles were not sudanophilic and therefore were regarded as glycogenic in origin. To obtain objective data concerning the extent of the vacuolization, livers were examined by computer assisted morphometry. Measurements of profile area and perimeter of the hepatocyte nuclei and vacuoles were evaluated according to stereological principles. Results indicated that the volume density of the nuclei was less in the F group than in the S(p equal less than 0.0002) and V(p equal less than 0.001) groups. Mean volume of individual nuclei did not differ. Volume density of the vacuoles was greater in the F than in the V group (p equal less than 0.02) while their mean diameter was less (p equal less than 0.05). To ascertain the relationship between increase in liver weight of the

flight animals and the results of this study, an assumption was made that the specific gravity of the vacuolar contents was similar to the other extranuclear components of the hepatocyte. On that basis, calculations showed that the elevated vacuolar volume density in the flight group did not cause the increased liver weight in those animals, but that the non-nuclear, non-vacuolar parenchymal compartment did contribute significantly. Factors that may have played a causal role in liver weight and vacuolar compartment increases are discussed. Author

N90-26467*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENT K-6-13. MORPHOLOGICAL AND BIOCHEMICAL EXAMINATION OF HEART TISSUE. PART 1: EFFECTS OF MICROGRAVITY ON THE MYOCARDIAL FINE STRUCTURE OF RATS FLOWN ON COSMOS 1887. ULTRASTRUCTURE STUDIES. PART 2: CELLULAR DISTRIBUTION OF CYCLIC AMPDEPENDENT PROTEIN KINASE REGULATORY SUBUNITS IN HEART MUSCLE OF RATS FLOWN ON COSMOS 1887
D. E. PHILPOTT, K. KATO, J. STEVENSON, JAIME MIQUEL, M. I. MEDNIEKS, W. SAPP, I. A. POPOVA, and L. V. SEROVA (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 297-329 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

The left ventricle of hearts from rats flown on the Cosmos 1887 biosatellite for 12.5 days was compared to the same tissue of synchronous and vivarium control animals maintained in a ground based laboratory. The volume density of the mitochondria in the myocardium of the space-flown animals was statistically less (p equal less than 0.01) than that of the synchronous or vivarium control rats. Exposure to microgravity resulted in a certain degree of myocardial degeneration manifested in mitochondrial changes and accumulation of myeloid bodies. Generalized myofibrillar edema was also observed. Author

N90-26468*# Emory Univ., Atlanta, GA. Dept. of Biochemistry.
EXPERIMENT K-6-14. HEPATIC FUNCTION IN RATS AFTER SPACEFLIGHT
A. MERRILL, JR., M. HOEL, E. WANG, D. JONES, J. HARGROVE, R. MULLINS, and I. POPOVA (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 331-343 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

To determine the possible biochemical consequences of prolonged weightlessness on liver function, tissue samples from rats that had flown aboard Cosmos 1887 were analyzed for hepatic protein, glycogen and lipids as well as the activities of a number of key enzymes involved in metabolism of these compounds and xenobiotics. Among the parameters measured, the major differences were elevations in the hepatic glycogen content and HMG-CoA reductase activities of the rats flown on Cosmos 1887, and a decrease in the amount of microsomal cytochrome P sub 450 and the activity of aniline hydroxylase, a cytochrome P sub 450-dependent enzyme. Decreases in these two indices of the microsomal mixed-function oxidase system indicated that spaceflight may compromise the ability of liver to metabolize drugs and toxins. The higher HMG-CoA reductase correlated with elevated levels of serum cholestrol. Other changes included somewhat higher blood glucose, creatinine, SGOT, and much greater alkaline phosphatase and BUN. These results generally support the earlier observation of changes in these parameters (Merrill et al., Am. J. Physiol. 252:R22-R226, 1987). The importance of these alterations in liver function is not known; however, they have the potential to complicate long-term spaceflight. Author

N90-26469*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENT K-6-16. MORPHOLOGICAL EXAMINATION OF RAT TESTES. THE EFFECT OF COSMOS 1887 FLIGHT ON SPERMATOGONIAL POPULATION AND TESTOSTERONE LEVEL IN RAT TESTES
D. E. PHILPOTT, K. KATO, J. STEVENSON, M. VASQUES, W. SAPP, C. WILLIAMS, I. A. POPOVA, and L. V. SEROVA (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 345-358 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

Testes from rats flown on Cosmos 1887 for twelve and a half days were compared to basal control, synchronous control and vivarium maintained rats. When the mean weights of flight testes, normalized for weight/100 gms, were compared to the vivarium controls they were 6.7 percent lighter. Although the flight testes were lighter than the synchronous, the difference is not significant. Counts of spermatogonial cells from 5 animals in each group revealed a 4 percent decrease in flight compared to vivarium controls. In both cases the t-Test significance was less than 0.02. The serum testosterone levels of all animals (flight, synchronous and vivarium) were significantly below the basal controls. Author

N90-26470*# Colorado State Univ., Fort Collins. Coll. of Veterinary Medicine and Biomedical Sciences.
EXPERIMENT K-6-17. STRUCTURAL CHANGES AND CELL TURNOVER IN THE RATS SMALL INTESTINE INDUCED BY SPACEFLIGHT
R. W. PHILLIPS, H. R. SAWYER, and K. V. SMIRNOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 359-363 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

The purpose of this project was to test the hypothesis that the generalized, whole body decrease in synthetic activity associated with microgravity conditions of space flight as evidenced by negative nitrogen balance and muscle atrophy (Nicogossian and Parker, 1982; Oganov, 1981), as well as inhibited lymphocyte proliferation (Bechler and Cogoli, 1986), would be evident in cells characterized by a rapid rate of turnover. As a model, researchers chose to study the turnover of mucosal cells lining the jejunum of the small intestine, since these cells are among the most rapidly proliferating in the body. Under normal conditions, epithelial cells that line the small intestine are continually produced in the crypts of Lieberkuhn. These cells migrate out of the crypts onto intestinal villi, are progressively pushed up the villus as new crypt cells are formed, and ultimately reach the tip of villi where they are then descquamated. In rats, the entire process, from initial proliferation in crypts to desquamation, takes approximately 2 days (Cairnie et al., 1965; Lipkin, 1973). In this study, researchers determined the mitotic index for mucosal cells lining the proximal, middle, and distal regions of the jejunum in rats from three treatment groups (synchronous control, vivarium control and flight), and measured the depth of the crypts of Lieberkuhn and the length of villi present in each of the three jejunal regions sampled. Author

N90-26471*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENT K-6-18. STUDY OF MUSCARINIC AND GABA (BENZODIAZEPINE) RECEPTORS IN THE SENSORY-MOTOR CORTEX, HIPPCAMPUS AND SPINAL CODE
N. DAUNTON, F. DAMELIO, and I. KRASNOV (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 365-370 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

Frontal lobe samples of rat brains flown aboard Cosmos 1887 were processed for the study of muscarinic (cholinergic) and GABA (benzodiazepine) receptors and for immunocytochemical localization of the neurotransmitter gamma-aminobutyric acid (GABA) and glial fibrillary acidic protein (GFAP). Although radioactive labeling of both muscarinic cholinergic and GABA (benzodiazepine) receptors proved to be successful with the techniques employed, distinct receptor localization of individual laminae of the frontal neocortex was not possible since the sampling of the area was different in the various groups of animals. In spite of efforts made for proper orientation and regional identification of laminae, it was found that a densitometric

(quantitation of autoradiograms) analysis of the tissue did not contribute to the final interpretation of the effects of weightlessness on these receptors. As to the immunocytochemical studies the use of both markers, GFAP and GABA antiserum, confirmed the suitability of the techniques for use in frozen material. However, similar problems to those encountered in the receptor studies prevented an adequate interpretation of the effects of micro-G exposure on the localization and distribution of GABA and GFAP. This study did, however, confirm the feasibility of investigating neurotransmitters and their receptors in future space flight experiments. Author

N90-26472*# San Jose State Univ., CA. Dept. of Biological Sciences.

EXPERIMENT K-6-19. PINEAL PHYSIOLOGY IN MICROGRAVITY: RELATION TO RAT GONADAL FUNCTION

D. HOLLEY, M. R. I. SOLIMAN, F. KADDIS, C. MARKLEY, and I. KRASNOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 371-385 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

One of the most interesting concomitants to spaceflight and exposure to microgravity has been the disturbing alteration in calcium metabolism and resulting skeletal effects. It was recognized as early as 1685 (cited in Kitay and Altschule, 1954) that the pineal of humans calcified with age. However, little can be found in the literature relating calcification and pineal function. Given the link between exposure to microgravity and perturbation of calcium metabolism and the fact that the pineal is apparently one of the only soft tissues to calcify, researchers examined pineal calcium content following the spaceflight. Researchers concluded that the spaceflight resulted in a stress response as indicated by adrenal hypertrophy, that gonadal function was compromised, and that the pineal may be linked as part of the mechanism of the responses noted. Author

N90-26473*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENT K-6-20. THE EFFECT OF SPACEFLIGHT ON PITUITARY OXYTOCIN AND VASOPRESSIN CONTENT OF RATS

L. KEIL, J. EVANS, R. GRINDELAND, and I. KRASNOV (Institute of Biomedical Problems, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 387-392 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

Pituitary levels of oxytocin (OT) and vasopressin (AVP) were measured in rats exposed to 12.5 days of spaceflight (FLT) as well as ground-based controls, one group synchronously maintained in flight-type cages with similar feeding schedules (SYN), and one group in vivarium cages (VIV). Flight rats had significantly less (p less than 0.05) pituitary OT and AVP(1.10 plus or minus 0.04 and 1.69 plus or minus 0.07 micron g, n=5) than either the SYN(1.60 plus or minus 0.08 and 2.11 plus or minus 0.04 micron g, n=5) or VIV (1.54 plus or minus 0.03 and 2.10 plus or minus 0.09 micron g, n=5) control groups, respectively. Because the FLT group mean body weight was significantly less (p less than 0.05) than either control group, the pituitary hormone content was also calculated on the basis of posterior pituitary protein content. When calculated in this manner, pituitary OT in the FLT rats (5.09 plus or minus 0.15 micron g/mg protein) was significantly less (p less than 0.05) than SYN(7.66 plus or minus 0.39 micron g/mg protein) or VIV controls (8.11 plus or minus 0.64 micron g/mg protein). Pituitary AVP was also less in the FLT animals (7.80 plus or minus 0.13 micron g/mg protein) compared to either SYN(9.84 plus or minus 0.51, p less than 0.05) or VIV controls (11.01 plus or minus 0.76, p less than 0.05). The reduced levels of pituitary OT and AVP may have resulted from increased hormone secretion resulting from the combined effects of water deprivation and the stress of the novel microgravity environment. Author

N90-26474*# Washington Univ., Saint Louis, MO.

EXPERIMENT K-6-21. EFFECT OF MICROGRAVITY ON 1) METABOLIC ENZYMES OF TYPE 1 AND TYPE 2 MUSCLE FIBERS AND ON 2) METABOLIC ENZYMES, NEUTRANSMITTER AMINO ACIDS, AND NEUROTRANSMITTER ASSOCIATED ENZYMES IN MOTOR AND SOMATOSENSORY CEREBRAL CORTEX. PART 1: METABOLIC ENZYMES OF INDIVIDUAL MUSCLE FIBERS; PART 2: METABOLIC ENZYMES OF HIPPOCAMPUS AND SPINAL CORD

O. LOWRY, D. MCDOUGAL, JR., PATTI M. NEMETH, M.-Y. CHI MAGGIE, M. PUSATERI, J. CARTER, J. MANCHESTER, BEVERLY NORRIS, and I. KRASNOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 393-418 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

The individual fibers of any individual muscle vary greatly in enzyme composition, a fact which is obscured when enzyme levels of a whole muscle are measured. The purpose of this study was therefore to assess the changes due to weightless on the enzyme patterns composed by the individual fibers within the flight muscles. In spite of the limitation in numbers of muscles examined, it is apparent that: (1) that the size of individual fibers (i.e., their dry weight) was reduced about a third, (2) that this loss in dry mass was accompanied by changes in the eight enzymes studied, and (3) that these changes were different for the two muscles, and different for the two enzyme groups. In the soleus muscle the absolute amounts of the three enzymes of oxidative metabolism decreased about in proportion to the dry weight loss, so that their concentration in the atrophic fibers was almost unchanged. In contrast, there was little loss among the four enzymes of glycogenolysis - glycolysis so that their concentrations were substantially increased in the atrophic fibers. In the TA muscle, these seven enzymes were affected in just the opposite direction. There appeared to be no absolute loss among the oxidative enzymes, whereas the glycogenolytic enzymes were reduced by nearly half, so that the concentrations of the first metabolic group were increased within the atrophic fibers and the concentrations of the second group were only marginally decreased. The behavior of hexokinase was exceptional in that it did not decrease in absolute terms in either type of muscle and probably increased as much as 50 percent in soleus. Thus, their was a large increase in concentration of this enzyme in the atrophied fibers of both muscles. Another clear-cut finding was the large increase in the range of activities of the glycolytic enzymes among individual fibers of TA muscles. This was due to the emergence of TA fibers with activities for enzymes of this group extending down to levels as low as those found in control soleus muscles. It would be interesting to know if this represents a transition stage, and whether with prolonged weightlessness most of the fibers would be transformed into a low glycogenolytic type. Author

N90-26475*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENT K-6-22. GROWTH HORMONE REGULATION, SYNTHESIS AND SECRETION IN MICROGRAVITY. PART 1: SOMATOTROPH PHYSIOLOGY. PART 2: IMMUNOHISTOCHEMICAL ANALYSIS OF HYPOTHALAMIC HORMONES. PART 3: PLASMA ANALYSIS

R. GRINDELAND, W. VALE, W. HYMER, P. SAWCHENKO, M. VASQUES, I. KRASNOV, A. KAPLANSKI, and I. VICTOROV (Brain Research Inst., Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 419-470 Feb. 1990

Avail: NTIS HC A22/MF A03 CSCL 06/3

The objectives of the 1887 mission were: (1) to determine if the results of the SL-3 pituitary gland experiment (1) were repeatable; and (2) to determine what effect a longer mission would have on the rat pituitary gland growth hormone (GH) system. In the 1887 experiment two issues were considered especially important. First, it was recognized that cells prepared from individual rat pituitary glands should be considered separately so that the

data from the 5 glands could be analyzed in a statistically meaningful way. Second, results of the SL-3 flight involving the hollow fiber implant and HPLC GH-variant experiments suggested that the biological activity of the hormone had been negatively affected by flight. The results of the 1887 experiment documented the wisdom of addressing both issues in the protocol. Thus, the reduction in secretory capacity of flight cells during subsequent extended cell culture on Earth was documented statistically, and thereby established the validity of the SL-3 result. The results of both flight experiments thus support the contention that there is a secretory lesion in pituitary GH cells of flight animals. The primary objective of both missions was a clear definition of the effect of spaceflight on the GH cell system. There can no longer be any reasonable doubt that this system is affected in microgravity. One explanation for the reason(s) underlying the better known effects of spaceflight on organisms, viz. changes in bone, muscle and immune systems may very well rest with such changes in bGH. In spite of the fact that rats in the Cosmos 1887 flight were on Earth for two days after flight, the data show that the GH system had still not recovered from the effects of flight. Many questions remain. One of the more important concerns the GRF responsiveness of somatotrophs after flight. This will be tested in an upcoming experiment. Author

N90-26476*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENT K-6-23. EFFECT OF SPACEFLIGHT ON LEVELS AND FUNCTION OF IMMUNE CELLS
A. D. MANDEL, G. SONNENFELD, W. BERRY, G. TAYLOR, S. R. WELLHAUSEN, I. KONSTANTINOVA, A. LESNYAK, and B. FUCHS (Institute of Human Morphology, Moscow, USSR) *In its* The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 471-480 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

Two different immunology experiments were performed on samples received from rats flown on Cosmos 1887. In the first experiment, rat bone marrow cells were examined in Moscow for their response to colony stimulating factor-M. In the second experiment, rat spleen and bone marrow cells were stained in Moscow with a variety of antibodies directed against cell surface antigenic markers. These cells were preserved and shipped to the United States where they were subjected to analysis on a flow cytometer. The results of the studies indicate that bone marrow cells from flown rats showed a decreased response to colony stimulating factor than did bone marrow cells from control rats. There was a higher percentage of spleen cells from flown rats staining positively for pan-T-cell, suppressor-T-cell and innate interleukin-2 receptor antigens than from control animals. In addition, a higher percentage of cells that appeared to be part of the myelogenous population of bone marrow cells from flown rats stained positively for surface immunoglobulin than did equivalent cells from control rats. Author

N90-26477*# San Francisco Univ., CA. Physics Research Lab.
EXPERIMENT K-6-24, K-6-25, K-6-26. RADIATION DOSIMETRY AND SPECTROMETRY
E. V. BENTON, A. FRANK, E. R. BENTON, V. DUDKIN, and A. MARENNYI (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 483-511 Feb. 1990
(Contract NCC2-521; NAG9-235)
Avail: NTIS HC A22/MF A03 CSCL 06/3

Radiation experiments flown by the University of San Francisco on the Cosmos 1887 spacecraft were designed to measure the depth dependence of both total dose and heavy particle flux, dose and dose equivalent, down to very thin shielding. Three experiments were flown and were located both inside and outside the Cosmos 1887 spacecraft. Tissue absorbed dose rates of 264 to 0.028 rad d(-1) under shielding of 0.013 to 3.4 g/sq cm of (7)LiF were found outside the spacecraft and 0.025 rad d(-1) inside. Heavy particle fluxes of 3.43 to 1.03 x 10 to the minus 3rd power cm -2 sub s -1 sub sr -1 under shielding of 0.195 to 1.33 g/sq cm plastic were found outside the spacecraft and 4.25 times 10 to the minus 4th power cm -2 sub s -1 sub sr -1 inside (LET infinity H2O greater than or equal to 4 keV/micron m). The corresponding heavy particle dose equivalent rates outside the spacecraft were 30.8 to 19.8 mrem d(-1) and 11.4 mrem d(-1) inside. The large dose and particle fluxes found at small shielding thicknesses emphasize the importance of these and future measurements at low shielding, for predicting radiation effects on space materials and experiments where shielding is minimal and on astronauts during EVA. The Cosmos 1887 mission contained a variety of international radiobiological investigations to which the measurements apply. The high inclination orbit (62 degrees) of this mission provided a radiation environment which is seldom available to U.S. investigators. The radiation measurements will be compared with those of other research groups and also with those performed on the Shuttle, and will be used to refine computer models employed to calculate radiation exposures on other spacecraft, including the Space Station. Author

N90-26478*# San Francisco Univ., CA. Dept. of Radiology.
EXPERIMENT K-6-27. ANALYSIS OF RADIOGRAPHS AND BIOSAMPLES FROM PRIMATE STUDIES
C. CANN, A. RAKHMANOV, and V. KAROLKOV (Institute of Biomedical Problems, Moscow, USSR) *In* NASA, Ames Research Center, The US Experiments Flown on the Soviet Biosatellite Cosmos 1887 p 513-519 Feb. 1990
Avail: NTIS HC A22/MF A03 CSCL 06/3

Serial high-contrast radiographs were obtained of both arms and the right leg of two flight and four control monkeys for the period L-60 to S+16. Longitudinal growth of the tibia, radius and ulna was linear over this period in the control monkeys. In the flight monkey for whom the feeder malfunctioned, there were significant decreases in growth of the long bones. There were also hypermineralized growth arrest lines produced in the distal radial and ulnar metaphyses following resumption of growth. In the other flight monkey, there was a suggestion of decreased long bone growth during flight and immediate postflight periods, but this recovered by the end of the postflight control experiment. There was also an increase in intracortical resorption, indicative of skeletal activation. No major changes in cortical thickness or other parameters were noted, but modification of the techniques to obtain very high quality radiographs in further studies should allow subtle changes in these processes to be quantified.
Author

N90-26479*# Florida Univ., Gainesville. Dept. of Aerospace Engineering, Mechanics and Engineering Science.
IMPLEMENTATION OF SENSOR AND CONTROL DESIGNS FOR BIOREGENERATIVE SYSTEMS Final Report
PEDRO R. RODRIGUEZ, ed. May 1990 118 p
(Contract NASW-4435)
(NASA-CR-186655; NAS 1.26:186655) Avail: NTIS HC A06/MF A01 CSCL 06/2

The goal of the Spring 1990 EGM 4001 Design class was to design, fabricate, and test sensors and control systems for a closed loop life support system (CLLSS). The designs investigated were to contribute to the development of NASA's Controlled Ecological Life Support System (CELSS) at Kennedy Space Center (KSC). Designs included a seed moisture content sensor, a porous medium wetness sensor, a plant health sensor, and a neural network control system. The seed group focused on the design and implementation of a sensor that could detect the moisture content of a seed batch. The porous medium wetness group concentrated on the development of a sensor to monitor the amount of nutrient solution within a porous plate incorporating either infrared reflectance or thermal conductance properties. The plant health group examined the possibility of remotely monitoring the health of the plants within the Biomass Production Chamber (BPC) using infrared reflectance properties. Finally, the neural network group concentrated on the ability to use parallel processing in order to control a robot arm and analyze the data from the health sensor to detect regions of a plant. Author

N90-26480*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
PROXIMATE COMPOSITION OF SEED AND BIOMASS FROM SOYBEAN PLANTS GROWN AT DIFFERENT CARBON MONOXIDE (CO2) CONCENTRATIONS
R. M. WHEELER, C. L. MACKOWIAK (Bionetics Corp., Cocoa Beach, FL.), and J. C. SAGER May 1990 30 p
(Contract NAS10-11624)
(NASA-TM-103496; NAS 1.15:103496) Avail: NTIS HC A03/MF A01 CSCL 06/2

Soybean plants were grown for 90 days at 500, 1000, 2000, and 5000 ubar (ppm) carbon dioxide (CO2) and compared for proximate nutritional va'ue. For both cultivars (MC and PX), seed protein levels were highest at 1000 (39.3 and 41.9 percent for MC and PX) and lowest at 2000 (34.7 and 38.9 percent for MC and PX). Seed fat (oil) levels were highest at 2000 (21.2 and 20.9 percent for MC and PX) and lowest at 5000 (13.6 and 16.6 percent for MC and PX). Seed carbohydrate levels were highest at 500 (31.5 and 28.4 percent for MC and PX) and lowest at 2000 (20.9 and 20.8 percent for MC and PX). When adjusted for total seed yield per unit growing area, the highest production of protein and carbohydrate occurred with MC at 1000, while equally high amounts of fat were produced with MC at 1000 and 2000. Seed set and pod development at 2000 were delayed in comparison to other CO2 treatments; thus the proportionately high fat and low protein at 2000 may have been a result of the delay in plant maturity rather than CO2 concentration. Stem crude fiber and carbohydrate levels for both cultivars increased with increased CO2. Leaf protein and crude fiber levels also tended to rise with increased CO2 but leaf carbohydrate levels decreased as CO2 was increased. The results suggest that CO2 effects on total seed yield out-weighed any potential advantages to changes in seed composition.
Author

N90-26481# Wisconsin Univ., Madison. Dept. of Botany.
GAS EXCHANGE CHARACTERISTICS AS INDICATORS OF THE BASIC LIMITING FACTORS IN PHOTOSYNTHESIS Cumulative Report, 1987 - May 1989
THOMAS D. SHARKEY 1989 8 p
(Contract DE-FG02-87ER-13785)
(DE90-012399; DOE/ER-13785/3) Avail: NTIS HC A02/MF A01

Photosynthesis provides essentially all of the primary productivity on Earth. The rate of photosynthesis varies widely between and even within species. The basic processes are similar in most C3 plant species and so the differences in the rate of photosynthesis must be governed by feedback mechanisms regulating the rate of photosynthesis to meet the needs of the plant. Understanding these feedback mechanisms may allow us to modify them to adapt photosynthesis to the needs of humans. Researchers have concentrated on one feedback mechanism. This feedback mechanism comes into play when the capacity for starch and sucrose synthesis cannot keep pace with the chloroplast's ability to produce triose phosphate. Researchers have demonstrated that this type of feedback can occur under natural conditions and that both electron transport and Rubisco (RuBP) carboxylase are reduced in activity during this feedback. It is demonstrated that the reduced activity of RuBP carboxylase is caused by reduced carbamylation. These studies have led researcher to speculate that the role of RuBP carboxylase decarbamylation (deactivation) is to regulate the pool of free phosphate inside the chloroplast stroma. In these and other ways this research has contributed to our understanding of how the rate of photosynthesis is established in plants and how that rate might be modified in the future. DOE

N90-26482# Illinois Univ., Urbana.
PHOTOSYNTHESIS IN INTACT PLANTS Progress Report
1990 36 p
(Contract DE-FG02-86ER-13594)
(DE90-013699; DOE/ER-13594/3) Avail: NTIS HC A03/MF A01

Progress in the two years since the last renewal application has been excellent. The approach of basing the field work on a sound foundation of laboratory studies has enabled is to use methods which provide unambiguous assays of well characterized reactions. Excellent progress was made in several laboratory studies which will have direct applications in future field work, and have introduced to the laboratory a range of molecular genetics techniques which will allows the exploration of new options in the attempt to understand function at the level of molecular structure.
DOE

N90-26483# University of Southern California, Los Angeles. Dept. of Chemistry.
COMPUTER SIMULATION OF CHEMICAL REACTIONS IN SYNTHETIC MODEL COMPOUNDS AND GENETICALLY ENGINEERED ACTIVE SITES Final Report, 1 Jul. 1989 - 30 Jun. 1990
ARIEH WARSHEL 23 May 1990 6 p
(Contract N00014-87-K-0507)
(AD-A222611) Avail: NTIS HC A02/MF A01 CSCL 06/1

The main objective of this project is to advance our understanding of the principles of biological recognition and specificity by using computer simulation approaches. Such approaches are expected to be essential for detailed elucidation of the origin of the enormous power of biological catalysts and to help in exploiting the resulting insight in designing a new generation of highly specific molecular systems. Our computer simulation models have progressed to the level where we can reproduce the effect of genetic modifications of enzymes on its catalytic power in a semiquantitative way. We are also able to estimate in a reasonable way the overall catalytic effect of some enzymes. In three years of this contract we have tried to exploit the fast accumulation of experimental information about genetically modified enzymes in developing clearer design principles. GRA

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AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

A90-43382#
AGE RELATED CHANGES IN PHYSICAL PERFORMANCE AND PHYSIOLOGICAL FUNCTIONS OF JASDF PILOTS
YOSHINORI KURIHARA Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 30, Sept. 1989, p. 45-64. In Japanese, with abstract in English. refs

A study of age-related changes in the physical functions of JASDF pilots using such variables as visual acuity and hearing threshold level, blood pressure, and physical performance is presented. Some of the general results obtained include: (1) physical performance levels of the pilots were gradually deteriorated with increasing age; (2) systolic blood pressure was maintained relatively low up to 40 years of age, and then increased with age, while diastolic pressure was elevated progressively with age; (3) visual accommodation showed a constant reduction with age; and (4) deterioration of hearing ability and increase in individual differences at 4000 Hz or higher frequencies were typical.
R.E.P.

A90-43453*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
AN OVERVIEW OF THE SPACE MEDICINE PROGRAM AND DEVELOPMENT OF THE HEALTH MAINTENANCE FACILITY FOR SPACE STATION
SAM LEE POOL (NASA, Johnson Space Center, Houston, TX) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, March 1988, p. 1-12. refs

Because the prolonged stay on board the Space Station will increase the risk of possible inflight medical problems from that on Skylab missions, the Health Maintenance Facility (HMF) planned for the Space Station is much more sophisticated than the small

clinics of the Skylab missions. The development of the HMF is directed by the consideration of three primary factors: prevention, diagnosis, and treatment of injuries and illnesses that may occur in flight. The major components of the HMF include the clinical laboratory, pharmacy, imaging system, critical-care system, patient-restraint system, data-management system, exercise system, surgical system, electrophysiologic-monitoring system, introvenous-fluid system, dental system, and hyperbaric-treatment-support system. I.S.

A90-43454#
AUTONOMIC NERVOUS SYSTEM PARTIALLY CONTROLS MUSCULAR ACTIVITY IN MAN
FUKIKO MATSUMOTO, KINJI UCHINO (Yokohama National University, Japan), and MASAAKI HATTORI (Hokkaido Tokai University, Sapporo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, March 1988, p. 13-18. refs

The effect of voluntary muscle contraction on the excitability of a single motor unit during tonic vibration reflex (TVR) was investigated by measuring the spike intervals (SIs) of action potentials of a single motor unit of human m. vastus medialis, as an index of its excitability during TVRs induced by a mechanical vibrator. The SI and heart-rate measurements were obtained during the 5-percent maximum voluntary contraction (MVC) period and for 30 sec after TVR reached a plateau phase. In order to observe effects of autonomous nervous system excitation on the excitability of alpha motoneuron, the Valsalva maneuver and the Aschner's test were performed during TVR. Results suggest that a single motor activity stimulated during TVR may be potentiated by central command required for a particular muscular action, as well as by stimulating the autonomous nerves. I.S.

A90-43455#
SLEEP AND FATIGUE OF FLIGHT CREW IN LONG-HAUL AVIATION
YUKO KUROSAKI, MITUO SASAKI (Japan Air Lines, Flight Crew Medical Service Dept., Tokyo, Japan), HIROSHI ITOH, and TUKASA KABASHIMA (Tokyo Jikeikai University, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, June 1988, p. 29-36. In Japanese, with abstract in English. refs

The effect of the sleep-pattern disturbance of B747 flight crew, during and after an 11-hr flight across multiple time-zones, on the physical well-being and the recordings of physiological-function detectors were investigated in 18 subjects. The results, obtained during the outbound flight, the 24-hr layover, and the return flight, showed that subjective fatigue scores and the Stanford Sleepiness Scales increased significantly 2 hrs after the take-off on the outgoing flight, and remained high throughout the return flight. During the layover, the subjects had more awakenings and longer wake periods after sleep onset than they had before the flight. I.S.

A90-43456#
RELATIONSHIP BETWEEN +GZ TOLERANCE AND PHYSICAL CHARACTERISTICS DURING GRADUAL AND RAPID ONSET RUNS
CHIEKO MIZUMOTO (Air Self-Defense Force, Aeromedical Laboratory, Tachikawa, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 25, June 1988, p. 37-47. refs

The relationship between the +Gz tolerance (evaluated at the point of losing peripheral vision) of pilots and the characteristics of the body built parameters of the pilot was investigated in 123 JASDF F-15 pilots during gradual-onset and rapid-onset runs (GORs and RORs, respectively) in a human-centrifuge. Results showed a significant difference between the two types of tests. In the GOR tests, the +Gz tolerance was found to correlate significantly with the eye-heart distance and the upper-body dimensions (such as the chest and the arm circumferences), indicating that the GOR tolerance is affected by the hydrostatic effect of +Gz. In the ROR tests, the +Gz tolerance correlated with the abdominal strength, the body fat ratio, and the skin-fold thickness, suggesting that the ROR tolerance is affected by the orthostatic effect of +Gz. I.S.

A90-44275
THYROARYTENOID MUSCLE ACTIVITY DURING HYPOXIA, HYPERCAPNIA, AND VOLUNTARY HYPERVENTILATION IN HUMANS
GIUSEPPE INSALACO, SAMUEL T. KUNA, FABIO CIBELLA, and REGINALD D. VILLEPONTEAUX (Texas, University, Galveston; CNR, Istituto di Fisiopatologia Respiratoria, Palermo, Italy) Journal of Applied Physiology (ISSN 0161-7567), vol. 69, July 1990, p. 268-273. Research supported by the Moody Foundation and CNR. refs
(Contract NIH-HL-27520; NIH-HL-20122; NIH-RR-73)
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The effects of progressive isocapnic hypoxia, hyperoxic hypercapnia, and voluntary hyperventilation in humans on the intramuscular electromyographic (EMG) activity of the thyro-arytenoid (TA) muscle were investigated. It was found that both phasic and tonic TA activity decreased progressively with increasing hypoxia or hypercapnia, although, at comparable tidal volume increments, the relative decrease in phasic TA activity was greater under hypoxia than under hypercapnia. During voluntary isocapnic hyperventilation, phasic TA activity decreased without a significant change in tonic activity. The results suggest that vocal cord position depends on the net balance of counteracting forces, both during quiet breathing and during involuntary and voluntary hyperpnea. I.S.

A90-44582#
HYPOTHESIS ON BUBBLE VOLUME OF ALTITUDE DECOMPRESSION SICKNESS AND RELATION BETWEEN O2 PREBREATHING TIME AND PRESSURE IN SPACE SUITS
GUOLIN XU and RUGUO ZHANG (Institute of Space Medico-Engineering, Beijing, People's Republic of China) Chinese Space Science and Technology (ISSN 1000-758X), vol. 9, Oct. 1989, p. 46-51. In Chinese, with abstract in English. refs

Suppose that the increase of the gas bubble volume is bound to be followed by the increase of the incidence of decompression sickness (DS). It can be deduced that relative volume of gas bubble in the tissue (the ratio between the bubble volume and the tissue volume, Vb/V) has linear relation to the ratio of N2 tension in the tissue before decompression and that after decompression. The N2 tension after decompression equals the sum of environmental pressure and synthetic pressure (Ps). Ps depends on activity level. When the activity level increases, Ps decreases, Vb/V increases, and the incidence of DS increases. In accordance with this hypothesis and experimental data on DS, the curves of the relation between O2 prebreathing time and the pressure in space suits are obtained. Author

A90-44626* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THRESHOLD ALTITUDE RESULTING IN DECOMPRESSION SICKNESS
K. V. KUMAR, JAMES M. WALIGORA (NASA, Johnson Space Center, Houston, TX), and DICK S. CALKINS (Krug International Corp., Technology Life Sciences Div., Houston, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 685-689. refs
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A review of case reports, hypobaric chamber training data, and experimental evidence indicated that the threshold for incidence of altitude decompression sickness (DCS) was influenced by various factors such as prior denitrogenation, exercise or rest, and period of exposure, in addition to individual susceptibility. Fitting these data with appropriate statistical models makes it possible to examine the influence of various factors on the threshold for DCS. This approach was illustrated by logistic regression analysis on the incidence of DCS below 9144 m. Estimations using these regressions showed that, under a noprebreathe, 6-h exposure, simulated EVA profile, the threshold for symptoms occurred at

approximately 3353 m; while under a noprebreathe, 2-h exposure profile with knee-bends exercise, the threshold occurred at 7925 m. Author

A90-44627
TRANSPORT AIRCRAFT CREW AND DECOMPRESSION HAZARDS - STUDY OF A POSITIVE PRESSURE SCHEDULE
H. MAROTTE, C. TOURE, G. FLORENCE, D. LEJEUNE, and M. KERGUELEN (Centre d'Essais en Vol, Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge, France) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 690-694. refs
Copyright

The protection of the transport aircraft crew against cabin decompression hazards at high altitude (Z less than 13,700 m) is achieved by positive-pressure breathing (PPB). Currently, many PPB schedules are used. The present research was performed to propose a PPB schedule, using the hypothesis of a decompression at high altitude, including a stay at the flight level and an emergency descent at the rate of 75 m/sec. The measures were arterial oxygen saturation, heart rate, speech capabilities, and psychomotor performance. It is shown that the best protection at 13,700 m is afforded when the PPB is included between 2 and 2.5 kPa. Author

A90-44628
SUSTAINED PERIPHERAL VASOCONSTRICTION WHILE WORKING IN CONTINUOUS INTENSE NOISE
KEITH MILLAR (Glasgow, University, Scotland) and MARK J. STEELS (Nottingham, University, England) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 695-698. refs
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The study examined the effects of exposure to continuous noise on pulse volume (vasoconstriction) and rate, as well as four-choice serial reaction time. There were two separate groups of 12 subjects that performed the 20-min task during simultaneous monitoring of their physiological response to continuous 93-dBA white noise or 70-dBA quiet control conditions. Pulse volume showed marked reduction, implying increased arousal, in the first 3-min exposure to noise. Although some habituation of the vasoconstriction response then occurred, pulse volume continued to remain significantly higher than in quiet throughout the work period. Serial choice performance was unaffected by noise. The results confirm that there is a physiological cost incurred when working in noise, justifying concern for long-term effects on noise-exposed people. Author

A90-44630
GENERALIZATION OF TOLERANCE TO MOTION ENVIRONMENTS
THOMAS G. DOBIE (U.S. Navy, Naval Biodynamics Laboratory; New Orleans, University, LA) and JAMES G. MAY (New Orleans, University, LA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 707-711. refs
(Contract N00205-88-M-E058)
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The aim was to determine to what extent training tolerance to one motion stimulus would generalize other motion experiences. Twenty subjects prone to motion sickness were selected and assigned to one of four groups after pretesting in a Dichgans and Brandt drum to determine their susceptibility to visually-induced apparent motion. They were also pretested with a VDT display of an expanding surface, and on a revolving/tilting chair. Subjects in the first group served as controls and received only cognitive counseling regarding their ability to tolerate motion environments. Subjects in the other groups received the same counseling coupled with incremental exposures to the drum, chair, or VDT, respectively. Posttests on each apparatus revealed that the treatments involving the chair and the drum provided specific increases in tolerance to the device used during treatment, and that the treatment involving the chair provided a generalized tolerance to visually-induced motion. These results support the notion that there are both specific and general components in learning to tolerate motion environments. Author

A90-44631* Pennsylvania State Univ., University Park.
THE EFFECTS OF FIXATION AND RESTRICTED VISUAL FIELD ON VECTION-INDUCED MOTION SICKNESS
ROBERT M. STERN, SENQI HU, RICHARD B. ANDERSON, HERSCHEL W. LEIBOWITZ, and KENNETH L. KOCH (Pennsylvania State University, University Park and Hershey) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 712-715. refs
(Contract NAG9-118)
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Approximately 60 percent of healthy human subjects experience motion sickness when exposed to a rotating optokinetic drum. Here, the effects of certain visual factors on susceptibility to motion sickness were determined. Vection data (illusory self-motion), horizontal eye movement recordings, subjective motion sickness report, and a measure of gastric myoelectric activity were obtained from 45 subjects, who were randomly divided into the following three groups: a control group that observed the entire visual field with no fixation, a group that fixated on a central target, and a third group that had a visual field restricted to 15 deg. The experimental session was divided into three 12-min periods: baseline, drum rotation, and recovery. The results showed that fixation greatly reduced nystagmus and slightly reduced vection. The restricted visual field slightly reduced nystagmus and greatly reduced vection. Both of these manipulations significantly reduced symptoms of motion sickness and abnormal gastric myoelectric activity. Author

A90-44632
THE ELECTROCARDIOGRAPHIC RESPONSE TO HIGH +GZ CENTRIFUGE TRAINING
JAMES E. WHINNERY (U.S. Navy, Naval Air Development Center, Warminster, PA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 716-721. refs
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The responses of 59 asymptomatic healthy flight surgeons to the acceleration profiles included in current USAF and USN high-G centrifuge training programs are documented. EKG dysrhythmias were frequently observed during exposure to both gradual and rapid-onset training profiles. Short self-limited episodes of ventricular tachycardia occurred in five subjects. Advanced Lown grade ventricular ectopy occurred in 13 subjects. The results suggest that significant ectopy frequently occurs during exposure to centrifuge training profiles. Since aircrew are expected to undergo high +Gz as part of their usual flying duties, EKG monitoring during high-G centrifuge training has not universally been a required part of the training exposures. Aircrew have not always accepted EKG monitoring during centrifuge training, fearing detection of certain cardiac dysrhythmias, which current aeromedical standards consider disqualifying for continued flying duties without clinical aeromedical evaluation. Based on the results of this study, EKG monitoring might be considered appropriate to ensure optimum medical safety during high-G centrifuge training. Author

A90-44633* California Univ., Davis.
THE EFFECT OF HYPERDYNAMIC FIELDS ON THE OXIDATIVE METABOLISM OF THE PARAVENTRICULAR NUCLEUS
DEAN M. MURAKAMI and CHARLES A. FULLER (California, University, Davis) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 722-724. refs
(Contract NAG2-349)
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An important issue in space biology and medicine is understanding the effect of gravitational changes on the mechanisms that regulate fluid homeostasis. The results of this study show that, following 7-d exposure to a 2 G or 3 G hyperdynamic field, rats exhibited a linear increase in the

cytochrome oxidase staining of neurons in the paraventricular nucleus (PVN). The elevated oxidative metabolism in the PVN suggests that there was an increase in the manufacturing and release of vasopressin into the plasma in response to a perceived hypovolemic condition caused by increased hydrostatic pressure and redistribution of fluid to the periphery. Since vasopressin also has widespread cardiovascular effects, it will be important to understand the relationship between vasopressin and altered gravitational fields. Author

A90-44634* Kansas State Univ., Manhattan.
BINDING OF ALPHA-FETOPROTEIN BY IMMOBILIZED MONOCLONAL ANTIBODIES DURING EPISODES OF ZERO-GRAVITY OBTAINED BY PARABOLIC FLIGHT
BRIAN S. SPOONER, JAMES A. GUIKEMA (Kansas State University, Manhattan), and GRADY BARNES (Abbott Laboratories, North Chicago, IL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 725-728. refs
(Contract NAGW-1197)
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Alpha-fetoprotein (AFP), a single-chain polypeptide which is synthesized by the liver and yolk sac of the human fetus, provided a model ligand for assessing the effects of microgravity on ligand binding to surface-immobilized model receptor molecules. Monoclonal antibodies, used as receptors for AFP, were immobilized by covalent attachment to latex microparticles. Zero gravity environment was obtained by parabolic flight aboard NASA 930, a modified KC-135 aircraft. Buring the onset of an episode of zero gravity, ligand and receptor were mixed. Timed incubation (20 s) was terminated by centrifugation, the supernatant removed, and microparticles were assessed for bound AFP by immunochemical methods. The extent of binding was not influenced by microgravity, when compared with 1-G controls, which suggests that aberrant cellular activities observed in microgravity are not the simple expression of altered macromolecular interactions. Author

A90-44635
MEDICINAL PROTECTION WITH CHINESE HERB-COMPOUND AGAINST RADIATION DAMAGE
RUIJUN ZHANG, JINKANG QIAN, GUANGHUA YANG, BAOZHEN WANG, and XIULAN WEN (Institute of Space Medico-Engineering, Beijing, People's Republic of China) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 729-731. refs
Copyright

Experiments were carried out on mice and on subjects irradiated for cancer therapy to evaluate the protective efficacy of a Chinese medicinal-herb-compound (CMHC). The lethality and the degree of leucopenia caused by radiation in mice medicated with CMHC were significantly less in comparison with control mice (p less than 0.01 and p less than 0.001, respectively). CMHC significantly improved the WBC and the thrombocytes in irradiated workers (p less than 0.01 and p less than 0.001, respectively). The WBC count of 40 patients under radiotherapy while treated with CMHC recovered from 3450 + or - 77/c mm to 5425 + or - 264/c mm (p less than 0.001); whereas, in the control group, without any medication, the WBC count dropped significantly (p less than 0.001). Author

A90-44636
PRESENT STATUS OF RADIAL KERATOTOMY MYOPIA SURGERY - AEROSPACE CONSIDERATIONS
STANLEY DIAMOND Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 732-734. refs
Copyright

Radial keratotomy (RK) is one of several corneal surgery operations recently developed to change the refraction of the eye. RK consists of four to eight deep radial incisions extending from the coronal edge to a small central optical zone, which flattens when the corneal scars heal. This decreases the myopia, or excess corneal dioptric power by 2.00 to 6.00 diopters. The drawbacks of RK for aviators consists of the following problems and side effects: (1) several ocular surgical complications, which may cause loss of vision; (2) glare and dazzle in flight effects; (3) imprecise and unpredictable results; (4) diurnal change of refraction and vision; (5) residual regular and irregular astigmatism; (6) a decrease of best corrected vision; (7) late prgressive hyperopia; and (8) greater susceptibility to aggravated ocular trauma. RK presently appears to be fraught with intrinsic hazards and is imprudent and inadvisable for pilots or aircrew, in whom long-term stable nonfluctuating asymptomatic keen vision is required in both bright and dim light. Author

A90-44637
FITNESS OF CIVIL AVIATION PASSENGERS TO FLY AFTER EAR SURGERY
MICHAEL MOSER (Graz, Universitaet, Austria) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 735-737. refs
Copyright

Movements of the tympanic membrane caused by changes in air pressure are conducted to the ossicles of the middle ear. The gliding mechanism of the malleus-incus articulation converts in-and-out movements of the eardrum into up-and-down movements of the stapes, thereby protecting the inner ear from static pressures. In certain ear operations, the replacement of a middle ear ossicle by a prosthesis disjoints the malleus-incus articulation or makes it rigid. Pressure is then transmitted in unattenuated form from the eardrum through the oval window to the inner ear. Impairment of pressure equilibrium, for example due to obstructed eustachian tubes, can lead to prosthesis displacement with severe injury to the vestibulocochlear apparatus. Thus patients should be advised to begin equilibration of pressure at the beginning of descent of commercial airlines or civil aviation flights, and to repeat it at brief intervals. Author

A90-44638
RENAL CALCULI IN ARMY AVIATORS
JOSEPH Y. CLARK (U.S. Army Aeromedical Center, Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 744-747. refs
Copyright

A study of U.S. Army active duty aviators was done using the Aeromedical Epidemiology Data Repository (AEDR) for the period of January 1984 through December 1987 to determine the incidence of renal calculi in this population. Age-specific rates were found to be highest in the 30-54-year age group. The overall annual incidence was determined to be 4.7/1000 population of white male aviators. After standardization to the 1960 U.S. white population, the incidence in aviators was found to be 2.2/1000, almost double that of a Rochester, MN male population (1.2/1000). The aviation environment may predispose Army aviators to dehydration and play an etiologic role in the genesis of renal calculi. Medical evaluation, treatment, and administrative disposition of Army aviators with renal calculi are also briefly discussed. Author

A90-44639
HIGH G TRAINING AND SUPERFICIAL PHLEBITIS - A CASE REPORT
FRANCIS X. SPEIDEL (U.S. Navy, Marine Corps Aircraft Station, Cherry Point, NC) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 748, 749.
Copyright

This is a report of bilateral phlebitis in an otherwise healthy 37-year-old male, occurring approximately 96 h post G-tolerance training. Of interest is an episode of significant physical activity occurring between the G-tolerance training and the onset of symptoms of phlebitis. Health care professionals seeing patients post G training need to be aware of unusual possible sequelae, especially vascular in origin. Further information is needed before a causal relationship between G-tolerance training and superficial phlebitis can be demonstrated. Author

A90-44652
GLC - A PRACTICAL DISCUSSION
ROBERT PATCH (USAF, Holloman AFB, NM) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 7, 8.
Copyright

Observations made during nine months of centrifuge training at Holloman Air Force Base in New Mexico are summarized. The L-1 anti-G straining maneuver which emphasizes a closed glottis, three-second strain with a 2.5 to 3.5 sec window, quick air exchange, and good muscle tensing is described. Common problems with this maneuver are listed including short strain, insufficient muscle tensing, long strains, and poor physical conditioning. Tips for troubleshooting in an effort to prevent G-induced loss of conciousness (GLOC) are provided. L.K.S.

A90-44653
DOING IT BETTER IN THE DARK
RICK MASON (U.S. Navy, Yuma, AZ) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 14-18.
Copyright

Night vision goggles (NVG) image intensification systems capabilities and limitations are presented and subsequent ground based training is discussed. NVG technology is detailed, focusing on the functions and operations of the image intensifier and the microchannel plate. Significant limitations of NVG include a reduction in field of view and in resolution capability. Inflight physiooptic issues are discussed, such as factors which determine whether an object is visible or not, accuracy of depth perception and distance estimation, and problems with contrast and dark adaptation. Postflight physiooptic issues such as color sensitivity and near depth perception are also addressed. It is pointed out that numerous mishaps involving NVG occur due to lack of a solid knowledge base on either the night environment or NVG capabilities and limitations. The U.S. Marine Nite Imaging and Threat Evaluation Lab, designed to demonstrate different learning objectives, is detailed. Suggestions for improving performance are offered. L.K.S.

A90-44654
USAF SPATIAL DISORIENTATION TRAINING
MIKE BOEHME (USAF, Langley AFB, VA) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 19, 20.
Copyright

The USAF's spatial disorientation training program is described, pointing out that the pilot's perception of orientation is the backdrop for all aspects of flight. A solid background in the physiological aspects involved in spacial orientation and disorientation is provided to pilots in order to illustrate how disorientation occurs, and three specific types of spatial disorientation are detailed. Classical types of spatial disorientation and special areas of concern such as focus trapping, empty field myopia, and aircraft design are also discussed with students followed by a presentation on prevention, recognition, and recovery procedures. It is pointed out that modern USAF aircraft mishap statistics reveal that, because of improvements in aircraft design and maintenance, human factors now play the leading role in fatal aircraft accidents. Recommendations for a maximum effective academic program are provided. L.K.S.

A90-44655
SPATIAL DISORIENTATION IN FLIGHT - SCOPE AND LIMITATIONS OF TRAINING
ALAN J. BENSON (RAF, Institute of Aviation Medicine, Farnborough, England) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 20-23.
Copyright

Aspects of training intended to reduce likelihood of in-flight disorientation and to enhance pilot ability to address such a problem are reviewed. Overall aviator training objectives include acquisition of both adequate knowledge concerning etiology and manifestations of spatial orientation and of skills necessary to cope with such a problem in flight. It is suggested that complementary ground and air instruction may be used to achieve specific training objectives. Methods for effective ground-based training are discussed and different devices for spatial disorientation training are mentioned, including a hand-propelled rotating chair and a centrifuge with gimballed cab. It is pointed out that, while some closed-loop simulator flying time is useful for identification and resolution of inappropriate sensory cues, and for development of optimal control strategies, there is little substitute for actual in-flight training. The importance of instrument flying training is emphasized. L.K.S.

A90-44657
CLINICAL HYPERBARIC MEDICINE
ERIC P. KINDWALL (Wisconsin, Medical College, Milwaukee) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 26-31. refs
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Non-pressure-related uses of the hyperbaric chamber in clinical medicine are discussed. The Committee on Hyperbaric Oxygenation of the Undersea and Hyperbaric Medical Society has approved 14 disorders for treatment in the chamber, including gas gangrene, carbon monoxide poisoning, refractory osteomyelitis, skin grafts and flaps, exceptional blood loss anemia, crush injury, radiation necrosis, mixed aerobic and anaerobic infection, and thermal burns. Advantages of hyperbaric treatment of these disorders are outlined and research areas meriting further investigation are listed and discussed. Potential exists for application of hyperbaric medicine in areas such as carbon tetrachloride poisoning, hydrogen sulfide poisoning, sickle cell crisis, spinal cord injury, closed head injury, purpura fulminans, intra-abdominal and intra-cranial abscesses, mesenteric thrombosis, central retinal artery occlusion, cystoid macular edema, Bell's palsy, and leprosy. L.K.S.

A90-44660
ADVERSE EFFECT OF NEGATIVE GZ ON SUBSEQUENT HIGH POSITIVE GZ - A NEED FOR RESEARCH AND EDUCATION
RONALD W. DIEDRICHS Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 36-38.
Copyright

The effects of an immediate transition from a sustained zero or negative Gz environment to a high sustained positive Gz are discussed. It is noted that, while it is believed that a virtual mirror image exists of the baroreceptor reflex portion of the G-time tolerence curve, the curve may be much worse than this due to high negative Gz hydrostatic pressures. Anecdotal evidence supports the suggestion that negative Gz has a deleterious effect on positive Gz performance and may therefore be a significant contributing factor in G-LOC statistics and may also negate much of the virtue of a G-awareness or G-warmup maneuver. L.K.S.

A90-44661
PULMONARY CONSIDERATIONS OF HIGH SUSTAINED +GZ ACCELERATION AND G PROTECTION
DAVID H. GLAISTER (RAF, Institute of Aviation Medicine, Farnborough, England) Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 39-43. refs
Copyright

The physiological effects of sustained acceleration on the lung are discussed and positive pressure breathing (PPB) is compared and contrasted with the pressure breathing during G (PBG). Theoretical pressure-flow relationships for a human lung during +Gz acceleration are provided, and pulminary ventilation, ventilation/perfusion ratio, and occurrence of acceleration atelectasis are discussed in detail. L.K.S.

A90-44777#
EFFECT OF JET LAG ON THE CIRCADIAN RHYTHM OF PLASMA MELATONIN
YUMIKO FUJITA, ICHIRO ASUKATA, HIROFUMI OHKOSHI, MIKIO UEMATSU, AKIRA SASAKI (Japan Airlines, Tokyo, Japan) et al. Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 26, Sept. 1989, p. 73-79. In Japanese, with abstract in English. refs

Plasma melatonin circadian profiles were investigated for 8 days

in a group of 3 subjects while they underwent an eastward 8-h time shift by jet flight. On each day, samples were collected at 7, 15, and 23 o'clock and plasma melatonin was measured by radioimmunoassay. In the basal study, 6 subjects (3 of which underwent the eastward 8-h time shift) were investigated for 3 days. The plasma melatonin profile was characterized by nocturnal elevation with the maximum value measured at 7 o'clock. A significant increase (a factor of 4) in the daytime melatonin level was observed on the first day after the eastward trip. In 2 out of 3 cases, the shifts in the acrophase were observed on day 5. Resynchronization of the plasma melatonin circadian profiles took 5-7 days. These data suggest that melatonin secretion rhythm is generated not only by light-dark or sleep-wake cycles but by other biological mechanisms. Author

A90-44863* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GAIN, NOISE, AND CONTRAST SENSITIVITY OF LINEAR VISUAL NEURONS
ANDREW B. WATSON (NASA, Ames Research Center, Moffett Field, CA) Visual Neuroscience (ISSN 0952-5238), vol. 4, 1990, p. 147-157. refs
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Contrast sensitivity is a measure of the ability of an observer to detect contrast signals of particular spatial and temporal frequencies. A formal definition of contrast sensitivity that can be applied to individual linear visual neurons is derived. A neuron is modeled by a contrast transfer function and its modulus, contrast gain, and by a noise power spectrum. The distributions of neural responses to signal and blank presentations are derived, and from these, a definition of contrast sensitivity is obtained. This formal definition may be used to relate the sensitivities of various populations of neurons, and to relate the sensitivities of neurons to that of the behaving animal. Author

A90-45125
SYMPATHETIC NERVES CONTROL THE NEW FORMATION OF MICROVESSELS INDUCED BY ADAPTATION TO HYPOXIA [SIMPATICHESKIE NERVY KONTROLIRUIUT PROTSESS NOVOOBRAZOVANIIA MIKROSOSUDOV, INDUTSIROVANNYI ADAPTATSIEI K GIPOKSII]
V. B. KOSHELEV, M. V. KONDASHEVSKAIA, and I. M. RODIONOV (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 311, no. 3, 1990, p. 756-758. In Russian. refs
Copyright

Experiments were performed on white rats to study the role of the sympathetic nervous system in the process of angiogenesis induced by exposure to simulated high-altitude hypoxia. It is shown that hypoxia-induced angiogenesis is significantly reduced in animals deprived of sympathetic innervation. B.J.

A90-45741
A MATHEMATICAL MODEL FOR RESPONSE OF THE CORONARY CIRCULATION TO HIGH SUSTAINED GRAVITATIONAL FORCE FIELDS
SOPHIA HUAI ZHOU, EMILIA MATEEVA, and RICHARD COLLINS IN: Advances in fluid dynamics. New York, Springer-Verlag, 1989, p. 284-304. Sponsorship: Department of Supply and Services of Canada. refs
(Contract DSS-W7711-7-7029)
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A new model for the complete coronary circulation is formulated here which will provide improved insight into the response of the heart to regimes of high sustained gravity. The unsteady quasi-one-dimensional coronary blood flow is modeled in a branching network of distensible vessels subject to periodic collapse under the time- and space-dependent variations of the intramyocardial pressure which loads the coronary vessels externally. A schematic representation is given of the anatomy of the complete coronary circulation and the best reported estimates to date of vessel wall elasticity. A hybrid method of characteristics and a Lax-Wendroff two-step finite-dfference scheme are described for computing the coronary flow field. C.D.

A90-45781
SURVIVAL IN SPACE: MEDICAL PROBLEMS OF MANNED SPACEFLIGHT
RICHARD HARDING London and New York, Routledge, 1989, 249 p. refs
Copyright

The basic features of the space environment are reviewed, and the history and current status of efforts to protect humans from its immediate and long-term adverse effects are described, in an introduction for the general reader. Chapters are devoted to pressure and density; increased accelerations; radiation and micrometeoroids, temperature and humidity; nutrition, waste, and personal hygiene; dressing for space and mobility; health care; selection and training; microgravity; and the psychology of space flight, women in space, and spacecraft habitability. Diagrams, drawings, graphs, and photographs are provided. T.K.

N90-25459# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
NECK INJURY IN ADVANCED MILITARY AIRCRAFT ENVIRONMENTS
Feb. 1990 201 p In ENGLISH and FRENCH Symposium held in Munich, Fed. Republic of Germany, 24-28 Apr. 1989 (AGARD-CP-471; ISBN-92-835-0541-7) Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Anecdotal evidence suggests that soft tissue neck injury may be an occupational hazard for fighter pilots, particulary those in the later generation trainer and combat aircraft. Recent advances in helmet-mounted devices increase the potential for injury. There is an acute need for guidance on the maximum mass and mass distribution characteristics of head-mounted devices. The extent of risk and its control through the design of helmet-mounted devices, protective systems, and aircrew training and conditioning are discussed.

N90-25460# Air Force Medical Group (347th), Moody AFB, GA.
PREVALENCE OF G-INDUCED CERVICAL INJURY IN US AIR FORCE PILOTS
RODGER D. VENDERBEEK *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 7 p Feb. 1990 Submitted for publication
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Pilots of high performance aircraft are frequently exposed to significant accelerative forces; the effect of this exposure on the cervical vertebral column is an unquantified clinical and epidemiological problem. The findings are presented from a period of prevalence study of acute neck injury secondary to high G forces in U.S. Air Force pilots. A sample of 437 pilots of three different fighter aircraft was surveyed, and the data is stratified and analyzed to test the strength of association of injury prevalence with pilot age, type of aircraft, and type of flying environment. Results indicate that minor injury is common in these pilots, and that higher aircraft performance is associated with increased injury prevalence. Increased age is associated with increased prevalence of major cervical injuries. Preventive strategies may be helpful in reducing injury frequency and in avoiding serious injuries. Author

N90-25461# Nebraska Univ., Omaha. Dept. of Otolaryngology.
NON-EJECTION NECK INJURIES IN HIGH PERFORMANCE AIRCRAFT
DAVID G. SCHALL *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 10 p Feb. 1990
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The potential for significant neck injuries exists in today's high

performance fighter aircraft. The G-loads required to produce injury need not be excessive, nor is experience level necessarily protective. Eight cervical spine injury cases, due to or aggravated by +G(sub z) in F-15 and F-16 aircrew members are reviewed. These include two compression fractures (C5/C7), three left HNP's (C5-6/C6-7), one fracture of the spinous process (C7), one interspinous ligament tear (C6-7), and one myofascial syndrome (C6). Mechanisms of injury and evaluation are discussed. Exercise conditioning may play an important role in prevention and protection. The role of screening x rays and improving equipment remain as areas where further work needs to be done. Author

N90-25462# Belgian Air Force, Beauvechain.
A SURVEY OF CERVICAL PAIN IN PILOTS OF A BELGIAN F-16 AIR DEFENCE WING
I. BIESEMANS, M. INGELS, and P. VANDENBOSCH (Belgian Air Force, Brussels.) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 5 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Since the F-16 replaced the F-104 Starfighter in 1977, the pilots of the 1 deg Fighter Wing (1 deg FW) complained frequently from neck injuries sustained during and after their High + Gz interceptions. Until recently, Aerospace Medical community paid scant attention to this new clinical problem, although it was well known among pilots flying high performance aircraft (HPA) and flight surgeons. The results of an anonymous questionnaire, concerning neck problems in pilots flying the F-16 in an almost exclusive air to air role is communicated. A sample of 30 pilots answered these questionnaires in 1984 and in 1988. Analysis of these questionnaires showed 50 percent of the pilots reported having neck problems flying the F-16. No positive correlation between the age of the pilots and the prevalence of cervical pain could be demonstrated in this small group of fighter pilots. Subsequent factors in the neck injuries are the weight of the flying helmet as well as the combination of an inappropriate and insufficient physical training program. Neck injuries in pilots of HPA are a real occupational hazard and further long term follow up studies are needed to assess an eventually cumulative effect of repetitive high G loading on the cervical spine. Author

N90-25463# Royal Norwegian Air Force, Oslo. Inst. of Aviation Medicine.
RADIOLOGICAL INVESTIGATION OF THE VERTEBRAL COLUMN OF CANDIDATES FOR MILITARY FLYING TRAINING THE THE ROYAL NORWEGIAN AIR FORCE
HARALD T. ANDERSEN *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 6 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Neck injury with associated pain in the cervical spine and its supporting structures of ligaments and muscles are frequent complaints among aviators flying high performance fighter (HPF) aircraft. Two recent surveys conducted among air crew of the United States Air Force (USAF) and the United States Navy (USN), respectively, report incidences of neck pain incurred during flight of approximately 50 and 75 percent in these two HPF pilot populations (Knudsen et al., 1988, Vanderbeek 1988). Muscular pain, ruptured ligaments, sliding vertebrae and compression fractures were described resulting from violent manuevering during HPF air combat exercises (Andersen 1988). The cervical spinal column carries a heavy load during high-G accelerations supporting the head and various pieces of personal flying equipment. This top - heaviness is expected to increase further with night vision goggles and integrated weapon systems control devices added in an attempt to extend operable conditions. Moreover, since the aeromedical emphasis was on developments supporting cardio-vascular and respiratory functions, the neck and the delicate structures of vessels and nerves running with it are becoming increasingly vulnerable to damage. Literarily speaking, the neck has become pinched between the desire to add weight to the head for purposes other than protection, and, the support to cardio-vascular and respiratory organ systems which allows additional intensity and time spent during excursions into the high-G environment. For these reasons, and because the vertical column is relatively inaccessible to clinical examination, the medical selection procedures for military flying training with the Royal Norwegian Air Force (RNoAF) were extended some years ago to include a series of roentgen films of the vertebral column with emphasis on the cervical spine. Main findings and their consequences for admission to military flying training are presented. Author

N90-25464# Royal Norwegian Air Force, Oslo.
DATA ANALYSIS IN CERVICAL TRAUMA
LEIF A. LEVIN, HARALD T. ANDERSEN, LEON E. KAZARIAN, PATRICK HAYES, and HARALD U. SVERDRUP (Oslo Emergency Medical Center, Norway) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 5 p Feb. 1990
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The curvature of the cervical spine in lateral view is discussed and a method based on statistical analysis is used to reproduce quantitative data of the curvature. Part 1 is a study based on the lateral view in the neutral position in 142 aviators. The radiograms are divided in 3 main groups: normal cervical lordosis; marked straightening of the cervical spine; segmental straightening with reversal of the curve. Part 2 discusses the use of the digital analysis to determine the displacement in subjects that have sustained ligamentous injuries of the cervical spine following whiplash injury. Author

N90-25465# National Defence Medical Centre, Ottawa (Ontario). Rehabilitation Centre.
PROGRESSIVE CERVICAL OSTEOARTHRITIS IN HIGH PERFORMANCE AIRCRAFT PILOTS
MARTIN H. GILLEN and DENIS RAYMOND *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 6 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Thirty-one pilots who were subjected to a repetitive +G(sub z) environment were evaluated clinically and roentgenographically against age and sex-matched controls. Analyses demonstrated significant deterioration in the young pilot groups compared to controls in terms of neck range of motion, osteophytic spurring at C5/C6 and disc space narrowing at C4/5 and C5/6. While the pilots remain relatively asymptomatic during their flying career, they may be at greater risk for symptomatic cervical disease later in life. The +G(sub z) environment appears to play a role in an accelerated rate of cervical osteoarthritis in high performance pilots. This must be taken into consideration when systems that will increase the longitudinal impact load on the neck are being contemplated. Author

N90-25466# Amsterdam Univ. (Netherlands). Academisch Medisch Centrum.
ELECTRONYSTAGMOGRAPHIC FINDINGS FOLLOWING CERVICAL INJURIES
W. J. OOSTERVELD, H. W. KORTSCHOT, G. G. KINGMA, H. A. A. DEJONG, and M. R. SAATCI *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 4 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The biomechanical model of the head-neck system pursuits a whole spectrum of movements in all planes of motion and for a variety of speeds. The muscle actions are constrained by the physical properties of the vertical column, whose articulations differ in their ranges and directions of mobility. This model has three types of elements: the flexible beams; the rigid mass of the head; and the neck muscle complex. Origins and insertions, axial rotation and muscle tensions can be approximated easily, so that the

resulting peak static torques are compatible with the known torques generated voluntarily in various directions. All types of rotational movements can be performed with this construction, while the axis of rotation changes automatically with changing conditions. The neck muscle system has eight neural controller locations and eight locations for sensory feed-back. It is clear that the complicated network of muscles and neural mechanisms makes the cervical area vulnerable to traumata. Among the blunt traumas to the cervical region are the acceleration-deceleration accidents, better known as cervical whiplash injuries. One hundred and seventy-three patients, suffering from the consequences of an acceleration accident of the neck were investigated during the last two years. All patients acquired the trauma at an automobile accident. The patients visited the department because of consistent complaints as headache, dizziness, tinnitus and visual disturbances. In all patients an ENT investigation, audiometry, vestibulometry and visual tracking tests were performed. Although all patients had the type of injury in common, combinations of complaints differed considerably. The results of the examinations are discussed.
Author

N90-25467# Naval Air Systems Command, Washington, DC. Escape Systems.
AIRCREW NECK INJURIES: A NEW, OR AN EXISTING, MISUNDERSTOOD PHENOMENON
FREDERICK C. GUILL and G. RONALD HERD *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 12 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The first U.S. Navy ejection occurred on 9 August 1949. Since then, the Navy has experienced 4,335 ejections through March 1988. The first serious neck injury, a paracervical strain, associated with an ejection occurred on 20 February 1953. That injury, also, was the Navy's first vertebral/ paravertebral injury associated with ejection. Initially, assessment of such neck injuries was accomplished as simply another vertebral injury; however, in more recent years it has become more apparent that the cervical/paracervical injuries reported in connection with ejections do not exhibit the same pattern characteristics as other vertebral/paravertebral injuries. The injuries occur at different rates than would be expected based upon the rates of injury for other vertebral regions. Further, although a clear relationship between through-the-canopy ejection and higher incidence rates of vertebral injuries was established, (and a causal mechanism identified), that appeared not to be the case cervical/paracervical injuries. In addition, while vertebral/paravertebral injury incidence rates have fallen with the changes in catapult boost acceleration, cervical/paracervical injury incidence rates have steadily increased. Why cervical/paracervical injuries associated with ejection are increasing; why have they not declined as the injury incidence rates have for other spinal regions are examined. Anecdotal and statistical mishap data examined and compared in this and prior studies suggest that the answer might lie in the aircraft maneuvering capabilities and in the increased frequency of ejection during, or following, gyrations resulting from loss of control of aircraft. The answers obtained suggest that considerable caution needs to be exercised in the current trend to integrate manifold systems elements into aircrew helmets, especially in light of the man-limited capabilities of today's modern tactical aircraft. Author

N90-25468# Duke Univ., Durham, NC. Dept. of Biomedical Engineering.
FLEXION, EXTENSION AND LATERAL BENDING RESPONSES OF THE CERVICAL SPINE
JAMES H. MCELHANEY, BRIAN J. DOHERTY, JACQUELINE G. PAVER, BARRY S. MYERS, and LINDA GREY *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 10 p Feb. 1990
(Contract R49/CCR402396-02)
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The lateral, anterior, and posterior passive bending responses of the human cervical spine were investigated using unembalmed cervical spinal elements obtained from cadavers. Bending stiffness was measured in six modes ranging from tension- extension through compression-flexion. A five-axis load cell was used to establish the end conditions. Results include moment-angle curves, relaxation moduli and the effect of cyclic conditioning on bending stiffness. The Hybrid 3 ATD neck was also tested and its responses are compared with the human. It was observed that the Hybrid 3 neck was more rate sensitive than the human, that mechanical conditioning significantly changed the stiffness of the human specimens, and that changing the end-condition from pinned-pinned to fixed-pinned increased the stiffness by a large factor. The bending stiffness was significantly influenced by the direction of the bending moment, the type of end restraint, the magnitude of the deformation and the previous deformation history. The shear force produced by the end conditions was an important factor in the applied moment. This shear force not only changes the moment acting on the specimen but also influences the failure mode. These experiments indicate that when the loading is eccentric (as it almost always is), the primary deformation mode is bending, and the moment applied to the specimen is strongly influenced by shear forces and the magnitude of the eccentricity. The axial load is therefore a poor indicator of the type and magnitude of failure stresses. MR and CT was used to visualize the damage after loading. When compared to the dissection results MR was clearly superior to CT in detecting soft tissue and ligamentous injuries.
Author

N90-25469# Naval Biodynamics Lab., New Orleans, LA.
A KINEMATIC/DYNAMIC MODEL FOR PREDICTION OF NECK INJURY DURING IMPACT ACCELERATION
MARC S. WEISS, S. J. GUCCIONE, JR., and TERRY A. WATKINS (New Orleans Univ., LA.) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 6 p Feb. 1990
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A statistical study was made of six head kinematic response curves for a set of 57 human and 29 animal (rhesus) -X impact acceleration tests conducted at the Naval Biodynamics Laboratory. The acceleration levels ranged from six to fifteen g's for humans and 42 to 106 g's for animals. The six analyzed responses included the X and Z components of the linear acceleration and displacement and the Y axis angular acceleration and displacement. Each head kinematic response variable was nonlinearly regressed on sled acceleration profile and head orientation parameters. Regression equations for rhesus and human kinematics had the same exponential functional form with correlations ranging from 0.50 to 0.95. Statistical measures of goodness-of-fit were highly significant. The results confirm that the rhesus head/neck is a good biomechanical model for the human. Extension of this approach can lead to the scaling of kinematics between humans and animals which can be used to develop an injury prediction model for humans. Future applications include re-analysis of previous results on the effects of mass distribution parameters on head/neck dynamic response. Author

N90-25470# Erasmus Univ., Rotterdam (Netherlands). Dept. of Biomedical Physics.
ANALYSIS OF THE BIOMECHANIC AND ERGONOMIC ASPECTS OF THE CERVICAL SPINE UNDER LOAD
C. J. SNIJDERS and E. R. ROOSCH (Royal Netherlands Air Force, Soesterberg.) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 8 p Feb. 1990
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In high performance aircraft complicated loading situations arise, e.g., when the head of the flier is turned backwards and rapid accelerations appear. To obtain more insight in the forces

on the cervical spine a spatial biomechanical computer model was introduced. The research started with the development of a kinematic model which imposes the axes of rotation and mutual position of head and vertebrae in relation to flexion, extension, lateroflexion, and torsion. Subsequently lines of action of muscle forces were introduced as well as external loads acting on the center of mass of head and helmet born by gravity and by accelerations in different directions. Measurements were carried out of accelerations and head positions during several flights, a.o. representing air combat. Next, with the help of the biomechanical model, forces in vertebrae and muscles could be estimated. Although in the present stage of the research results of calculations must be interpreted carefully, conclusions can be drawn with respect to sitting posture, head position and helmet devices. Maximal forces calculated appear to be rather high. However, too few data on failure behavior exist to draw conclusions as to (long term) detrimental effects. Author

N90-25471# Calspan Corp., Buffalo, NY.
EFFECTS OF HEAD MOUNTED DEVICES ON HEAD-NECK DYNAMIC RESPONSE TO +G(SUB Z) ACCELERATIONS
EBERHARDT PRIVITZER and INTS KALEPS (Aerospace Medical Research Labs., Wright-Patterson AFB, OH.) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 14 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

An investigation is described which addresses the inertial loading effects of Head Mounted Device (HMD) on aviator head-neck-spine dynamic response during high +G(sub z) acceleration exposure. The primary objectives were to develop a methodology which could be used to establish limits on HMD inertial properties and to apply this methodology to the evaluation of the severity of the internal loads (occurring in the neck and upper spine) associated with certain specific HMD ensembles. The Head-Spine Model (HSM), a highly discretized, 3-D mathematical representation of the human head-spine-torso structure, was used to: establish a set of baseline response criteria (BRC); establish a preliminary methodology for setting limits on HMD inertial properties; and evaluate the severity of the loading associated with possible chemical defense (CD) ensembles. Author

N90-25472# Paris V Univ. (France). Lab. d'Anthropologie Appliquee.
DYNAMICAL MODIFICATIONS TO THE HEAD, LOAD FACTORS FROM ADDITIONAL WEIGHT [MODIFICATION DE LA DUNAMIQUE DE LA TETE, CHARGEE PAR DES MASSES ADDITIONNELLES]
P. Y. HENNION, A. COBLENTZ, and R. MOLLARD *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 8 p Feb. 1990 In FRENCH
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Numerous devices impose upon the user added weight on the head. Their use is almost a technical requirement. It is rare that the restrictions caused by their use is considered at their conception. This idea was studied for a commonly used system. For the first time, the location of the center and moment of inertia was studied by a experimental method. The change in the inertia parameters of a head with a device which adds weight was precisely followed in an analysis of the movement of the center of inertia and the various moments of weight on a bare head, and in relation to the center of rotation which remains unchanged. The influence of added weight was observed on four subjects with motion measured and identified as defined by target sighting which caused the head to rotate in many directions without added weight. From a dynamical aspect, some variations in the level and duration of the rotation acceleration were raised in relation to the increase of inertia. The offset of the center of inertia was also induced by the vertical acceleration perturbation. This was confirmed by an increase of activity in cervical neck muscles, and from movement of the head by use of muscles in the nape of the neck. Another observation of lesser import was obvious, the interference caused by the introduction of devices for the maintenance of posture. Some strong variations were seen in stabilograms while target sighting when in an upright position. This change in head dynamics leads to a perceptable loss of performance, as seen by errors and an increased response time in the sighting of aerial targets. Equipment designers do not think of operator efficiency when adding weight to the head with helmet mounted devices. It is established in this study that the functional senses of the operator must be considered as well as the increased inertia and performance criteria. Transl. by E.R.

N90-25473# Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge (France). Centre d'Essais en Vol.
MOBILITY OF THE HEAD AND LOAD EFFECTS: EXPERIMENTAL APPROACH IN A CENTRIFUGE [MOBILITE DE LA TETE ET FACTEUR DE CHARGE: APPROCHE EXPERIMENTALE EN CENTRIFUGEUSE]
A. LEGER, P. SANDOR, J. M. CLERE, and G. OSSARD *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 8 p Feb. 1990 In FRENCH
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The environment of modern combat pilots is very hazardous for the head-neck systems. The introduction of helmet mounted optronic systems caused even more problems with high G acceleration. Studies in centrifuges were used in order to show the influence of some environmental parameters (tilt of seat, high G and variations of acceleration forces) on head mobility. Two hundred and eighty centrifugal turns were made without causing traumatic injuries. The results show that up to 5 G, the head movements are changed very little. However, variations in the level of acceleration bring about perturbations of stability. The subsystems reflexes involved in head stabilization are influenced by voluntary control, these optional controls during aviation combat will be able to establish points of interest in the study of physiopathology of the pilot head-neck system. Transl. by E.R.

N90-25474# German Air Force, Fuerstenfeldbruk (Germany, F.R.). Inst. of Aerospace Medicine.
NECK INJURY PREVENTION POSSIBILITIES IN A HIGH-G-ENVIROMENT EXPERIENCE WITH HIGH SUSTAINED +G(SUB Z) TRAINING OF PILOTS IN THE GAF IAM HUMAN CENTRIFUGE
W. H. WURSTER, J. LANGHOFF, and E. C. BURCHARD *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 6 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

New generations of high performance military aircraft are able to produce higher G-rates of onset, attain higher G-levels for prolonged periods and in the future will confront man and machine more often with changing acceleration peaks than previous fighter generations have. These enhanced performance capabilities will require additional anti-G protection equipment as well as special education and training of pilots to tolerate high-G environment levels so they can fulfill complex tasks during special inflight conditions without suffering from G-induced cardiovascular, pulmonary, cerebral or musculoskeletal problems. Therefore an extensive study in 238 young G-stress unexperienced pilot candidates (aged between 18 to 24 years) of the GAF - Officers' - Academy was performed within a period of 23 months (1 Oct. 1985 to 1 Sep. 1987) who participated in a high-G training program as volunteers with more than 1250 centrifuge rides partially up to +8 G(sub z) for 30 sec on the GAF IAM Human Centrifuge. By means of an anonymous questionnaire answered by the pilot candidates immediately after G(sub z) exposure and post-acceleration check-up, different data were obtained. The intention of this investigation was in maintaining vision and consciousness as well as neck injury prevention at high sustained

+G(sub z) levels in G-unexperienced pilot candidates. The findings in the search for methods to protect a subject under +G(sub z) stress in the human centrifuge from G-induced symptoms, especially of potential cervical spine problems, are described.
Author

N90-25475# Association Peugeot-Renault, Nanterre (France). Lab. de Physiologie et de Biomecanique.
RISK OF CERVICAL INJURY IN REAL AND SIMULATED ACCIDENTS [RISQUE DE LESIONS CERVICALES EN ACCIDENTS REELS ET SIMULES]
C. TARRIERE, J. Y. FORET-BRUNO, J. Y. LECOZ, C. GOT, and F. GUILLON (Hopital Raymond Poincare, Garches, France) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 17 p Feb. 1990 In FRENCH
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The Lab of Physiology and Biomechanics in association with PSA and Renault made use of two sources of data which adds to the understanding of risk and mechanics associated with vertebral injury. The data is from real multidisciplinary tests of 6589 vehicle occupants involved in accidents with body injuries and 9789 injuries involving the front seat of a vehicle and from 375 experimental tests with cadavers (simulated frontal and lateral, free fall, collision tests, etc.). The first part is essentially about the risk of vertebral injury with or without direct impact on the head with only seat belt simulated in different types of real accidents. The second part concerns the tests with cadavers which gives a better understanding of the mechanics of vertebral injury, thanks to the measurement of different physical parameters (maximum angle of head-chest, speed and angular acceleration, etc.).
Transl. by E.R.

N90-25476# Waterloo Univ. (Ontario). Dept. of Kinesiology.
A COMPUTER SIMULATION MODEL FOR STUDYING CERVICAL SPINE INJURY PREVENTION
P. J. BISHOP and R. P. WELLS *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 5 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Cervical spine fractures, particularly of the burst type due to axial compressive loading of the spine, are a problem in sports and transportation. Such injuries are usually associated with a head first collision, in which the head strikes a rigid surface (e.g., windscreen, dashboard, etc.), with the neck partially to fully flexed. A computer simulation model was developed as one means by which protective devices can be evaluated. The model consists of two rigid masses (head and torso), three spring elements (dashpots and non-linear springs) representing the neck and the compliance of the cranium and scalp, and three optional spring elements taken to represent the characteristics of the protective devices. Simulations using the model, at impact velocities of 1.8 and 3.0 m/sec, suggest that to maintain cervical spine loads at a non-injurious level (e.g., below 20000N) requires a padding material thickness incompatible with wearing a helmet. Author

N90-25477# Institut de Recherche de Transports, Bron (France). Lab. de Chocs et de Biomecanique.
BIOFIDELITY OF A DUMMY'S NECK DURING AUTOMOBILE COLLISION TESTING [BIOFIDELITE DES COUS DE MANNEQUINS AU COURS DES ESSAIS DE CHOCS AUTOMOBILES]
R. WILLINGER and D. CESARI *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 11 p Feb. 1990 In FRENCH
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Dummies are widely used in research on the protection of automobile passengers. The dummies were designed for use in acquiring knowledge of the biomechanics of the human body subjected to collisions. The necks of some of the dummies were designed in such a way as to behave similar to those of humans. Herein, an analysis is proposed based also on a bibliographic survey, of the 3-D kinematics of the heads of dummies (SID, Hybrid 3, and EUROSID) with the object of studying their biofidelity. Generally, the biofidelity is better in frontal as opposed to lateral collisions. This is essentially explained by the fact that the head rotation around its vertical axis is not taken into account in the design of dummies. The biofidelity and performance of dummies rest on the biomechanic conclusions sometimes drawn from cadavers. The validity of these tests is studied along with suggestions for future testing. Transl. by E.R.

N90-25478# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Road-Vehicles Research Inst.
OMNI-DIRECTIONAL HUMAN HEAD-NECK RESPONSE
Abstract Only
J. WISMANS *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 1 p Feb. 1990 Presented at the 1986 STAPP Car Crash Conference
(SAE-861893) Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Naval Biodynamics Laboratory (NBDL) in New Orleans has conducted an extensive research program over the past years to determine the head-neck response of volunteers to impact acceleration. These subjects were exposed to impacts in frontal, lateral, and oblique directions. An analysis of a limited number of frontal and lateral tests from a test series conducted in the late seventies with two subjects showed that the observed head-neck dynamics can be described by means of a relatively simple 2-pivot analog system. This analysis is extended to a more recent NBDL test program with 16 human subjects. The database consists of 119 frontal, 72 lateral, and 62 oblique tests. The research methodology used for this analysis includes a detailed description of three-dimensional kinematics as well as load calculations near T1 and the occipital condyles. A description of this research methodology and a summary of the major test results is presented. Special attention is given to the influence of impact severity and impact direction on the head-neck dynamics. It is shown that a similiar analog system as proposed earlier for frontal and lateral impacts is suitable for all impact directions. Geometrical properties of this analog were determined by means of newly developed numerical techniques rather than through the graphical techniques that were used earlier. Findings of this analysis are discussed in view of future omni-directional mechanical neck developments.
Author

N90-25479# Naval Air Development Center, Warminster, PA.
MEASUREMENT TECHNIQUES, EVALUATION CRITERIA AND INJURY PROBABILITY ASSESSMENT METHODOLOGIES DEVELOPED FOR NAVY EJECTION AND CRASHWORTHY SEAT EVALUATIONS
GEORGE D. FRISCH, LAWRENCE E. KINKER, and PAUL H. FRISCH (Applied Physics, Inc., Nanuet, NY.) *In* AGARD, Neck Injury in Advanced Military Aircraft Environments 8 p Feb. 1990
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Head and neck injuries are of particular concern to Navy researchers and extensive programs were initiated to address head and neck response of both live human subjects and human analogs to crash impact forces. This concern was somewhat heightened by the apparently conflicting operational requirements of having canopy penetration as the principal means of ejection in several aircraft prototypes, coupled to the requirement of introducing night vision capability in attack aircraft. The latter will most probably lead to increased helmet volume, and possibly weight, which increases the probability of helmet canopy acrylic interaction during canopy penetration. Increased helmet weight and center of gravity shifts, together with altered helmet to head coupling, will certainly change head and neck response to even presumably safe exposure levels. In order to adequately parameterize head and neck response

and relate the gathered data to known living human subject and cadaver data, both inertial response and load data must be obtained at well defined, anatomically correctable points. A modified Hybrid 3 type head and neck complex was developed, ballasted to be in compliance with Navy generated head and neck mass distribution parameters, and fully instrumented at the head center of gravity (CG), occipital condyles, and the base of the neck. The fully instrumented head and neck system was utilized to evaluated various helmet configurations and the effect on head and neck response with changes in helmet weight and geometry. Additionally, neck extension, compression, shear forces, and torques were obtained during dynamic ejection tests ranging from 0/0 to 720 KEAS. At the higher speeds, the effects of aerodynamic lift can be identified on the monitored neck compression-tension values. With such data, injury modalitiens and probabilities can be addressed in considerably greater detail than the present norm and the effectiveness of protective equipment established.
Author

N90-25480*# National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CUMULATIVE INDEX TO A CONTINUING BIBLIOGRAPHY (SUPPLEMENT 332)
Jan. 1990 178 p
(NASA-SP-7011(332); NAS 1.21:7011(332)) Avail: NTIS HC A11; NTIS standing order as PB89-912300, $18.00 domestic, $36.00 foreign CSCL 06/5

This publication is a cumulative index to the abstracts contained in Supplements 320 through 331 of Aerospace Medicine and Biology: A Continuing Bibliography. Seven indexes are included -- subject, personal author, corporate source, foreign technology, contract number, report number and accession number. Author

N90-25481* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 337)
Jun. 1990 123 p
(NASA-SP-7011(337); NAS 1.21:7011(337)) Avail: NTIS HC A06; NTIS standing order as PB90-912300, $11.50 domestic, $23.00 foreign CSCL 06/5

This bibliography lists 400 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during May 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N90-25482* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 338)
Jul. 1990 57 p
(NASA-SP-7011(338); NAS 1.21:7011(338)) Avail: NTIS HC A04; NTIS standing order as PB90-912300, $11.50 domestic, $23.00 foreign CSCL 06/5

This bibliography lists 139 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during June 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N90-25483# European Space Agency, Paris (France).
STUDIES ON PREDICTING THE RESYNCHRONIZATION OF THE CIRCADIAN SYSTEM AFTER TRANSMERIDIAN FLIGHTS
MICHAEL RIPKENS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, Germany, F.R.) May 1990 120 p Transl. into ENGLISH from Untersuchung zur Vorhersage der Resynchronisation des zirkadianen Systems nach transmeridianen Fluegen (Cologne, Fed. Republic of Germany, DFVLR), Feb. 1989 122 p Original language document was announced as N90-12172
(ESA-TT-1177; DFVLR-FB-89-10; ETN-90-97079) Avail: NTIS HC A06/MF A01

Three flight experiments with 8 subjects each were carried out to study resynchronization in the circadian rhythms of different body functions after timeshifts of 6 and 9 hours. This was to examine whether the speed of adaptation could be predicted from the individual rhythm parameters of preflight control days. Significant correlations were found only in a few cases for some functions. Since, in addition, the reproductibility was too low, the hypothesis that it will be possible to predict the individual adaptation rate had to be rejected. This statement should not be generalized, as the number of subjects was too small and the procedure employed did not permit more general conclusions. ESA

N90-25484# European Space Agency, Paris (France).
BIOCHEMICAL AND PHYSIOLOGICAL CHANGES IN GLIDER PILOTS DURING MULTI-HOUR FLIGHTS
KLAUS GERECHT (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany, F.R.) May 1990 106 p Transl. into ENGLISH from Biochemische und physiologische Veraenderungen bei Piloten von Sogelflugzeugen waehrend laengerer Fluege (Cologne, Fed. Republic of Germany, DLR), Jun. 1989 118 p Original language document was announced as N90-13018
(ESA-TT-1183; DLR-FB-89-29; ETN-90-97082) Avail: NTIS HC A06/MF A01

Nine male glider pilots aged 21 to 43 years with above-average flight experience were investigated during 13 multi-hour glider flights. Blood and urine samples were taken before, during and after each flight. The results revealed a high sympathetic adrenomedullary and adrenocortical activity. Findings included a reduction in numbers of eosinophils, changes in blood lipid fractions due to induced lipolysis and an elevation of blood sugar concentrations during the flight going back to normal shortly after landing. Excretion of epinephrine was highest during the preflight period showing a high level of anticipatory stress, followed by moderate reductions during the flight as opposed to increasing excretion rates of norepinephrine and 17-hydroxycorticosteroids. This pattern possibly relates to a rise in fatigue with length of flight. Dehydration occurred in a spite of fluid-intake with high urinary output caused by pressure diuresis and kidney dysregulation induced by the Gauer-Henry-Refex by hyperventilation and half-supine position of the pilot in the glider plus undetermined losses via the skin and lungs. Subsequently loss of weight and elevated haematocrit were noted. Reduced serum potassium concentrations associated with more alkaline urine represent sequelae of hyperventilation, which is commonly found in pilots under flight stress. ESA

N90-25485# European Space Agency, Paris (France).
EFFECTS OF A TIME ZONE SHIFT OF 9 HOURS ON THE CIRCADIAN RHYTHMS IN COCKPIT AIRCREW MEMBERS ON LONGHAUL FLIGHTS
SILKE RUTH HASENCLEVER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany, F.R.) May 1990 83 p Transl. into ENGLISH from Auswirkungen einer Zeitzonenverschiebung von 9 Stunden auf die zirkadiane Rhythmik von Cockpitbesatzungen bei Langstreckenfluegen (Cologne, Fed. Republic of Germany, DLR), Jun. 1989 94 p Original language document was announced as N90-13019
(ESA-TT-1185; DLR-FB-89-31; ETN-90-97084) Avail: NTIS HC A05/MF A01

For 12 aircrew members on a flight schedule which crossed nine time zones, data for heart rate, temperature and the excretion of certain hormone metabolites and electrolytes in urine were continuously collected over a 7-day period, then analyzed for circadian rhythms. The results of rhythm analysis of these parameters are set out and the significance of such disruptions in body rhythm for this occupational group is illustrated. ESA

N90-25542*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
USEFULNESS OF HEART MEASURES IN FLIGHT SIMULATION
RANDALL L. HARRIS, SR., GREGORY A. BONADIES, and J. RAYMOND COMSTOCK, JR. *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 353-359 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 06/16

The results of three studies performed at the NASA Langley Research Center are presented to indicate the areas in which heart measures are useful for detecting differences in the workload state of subjects. Tasks that involve the arousal of the sympathetic nervous system, such as landing approaches, were excellent candidates for the use of average heart-rate and/or the increase in heart-rate during a task. The latter of these two measures was the better parameter because it removed the effects of diurnal variations in heart-rate and some of the intersubject variability. Tasks which differ in the amount of mental resources required are excellent candidates for heart-rate variability measures. Heart-rate variability measures based upon power spectral density techniques were responsive to the changing task demands of landing approach tasks, approach guidance options, and 2 versus 20 second interstimulus-intervals of a monitoring task. Heart-rate variability measures were especially sensitive to time-on-task when the task was characterized by minimal novelty, complexity, and uncertainty (i.e., heart-rate variability increases as a function of the subjects boredom). Author

N90-26484# Air Force Human Resources Lab., Williams AFB, AZ. Operations Training Div.
EYE TRACKING DEVICE FOR THE MEASUREMENT OF FLIGHT PERFORMANCE IN SIMULATORS Final Technical Report, Oct. 1987 - Apr. 1989
KEVIN W. DIXON, VICTORIA A. ROJAS, GRETCHEN M. KRUEGER, and LUKE SIMCIK Brooks AFB, TX AFSC Mar. 1990 13 p
(AD-A220075; AFHRL-TP-89-18) Avail: NTIS HC A03/MF A01 CSCL 06/16

The use of an eye position monitor as a research tool for evaluating the field-of-view (FOV) requirements for simulator visual systems is discussed. Traditional evaluation methods rely on the use of pilot opinion and/or objective pilot performance measures. Neither provides a direct index of the pilot's visual behavior under alternative FOV conditions. Without a direct measure, interpretation of data is often problematic. The use of an eye position monitor provides a useful adjunct to these traditional methods. Described here are the system architecture, initial implementation, advantages and limitations, and future application. GRA

N90-26485*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
HEMODYNAMIC AND ADH RESPONSES TO CENTRAL BLOOD VOLUME SHIFTS IN CARDIAC-DENERVATED HUMANS
V. A. CONVERTINO, C. A. THOMPSON, B. A. BENJAMIN, L. C. KEIL, W. M. SAVIN, E. P. GORDON, W. L. HASKELL, J. S. SCHROEDER, and H. SANDLER (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) 1990 29 p
(Contract NAS10-10285)
(NASA-TM-103471; NAS 1.15:103471) Avail: NTIS HC A03/MF A01 CSCL 06/16

Hemodynamic responses and antidiuretic hormone (ADH) were measured during body position changes designed to induce blood volume shifts in ten cardiac transplant recipients to assess the contribution of cardiac and vascular volume receptors in the control of ADH secretion. Each subject underwent 15 min of a control period in the seated posture, then assumed a lying posture for 30 min at 6 deg head down tilt (HDT) followed by 20 min of seated recovery. Venous blood samples and cardiac dimensions (echocardiography) were taken at 0 and 15 min before HDT, 5, 15, and 30 min of HDT, and 5, 15, and 30 min of seated recovery. Blood samples were analyzed for hematocrit, plasma osmolality, plasma renin activity (PRA), and ADH. Resting plasma volume (PV) was measured by Evans blue dye and percent changes in PV during posture changes were calculated from changes in hematocrit. Heart rate (HR) and blood pressure (BP) were recorded every 2 min. Results indicate that cardiac volume receptors are not the only mechanism for the control of ADH release during acute blood volume shifts in man. Author

N90-26486# Tel-Aviv Univ. (Israel).
ADJUSTMENT AND VALIDATION OF THE MATHEMATICAL PREDICTION MODEL FOR SWEAT RATE, HEART RATE, AND BODY TEMPERATURE UNDER OUTDOOR CONDITIONS Final Report, 7 Oct. 1985 - 7 Oct. 1987
Y. SHAPIRO, D. MORAN, and Y. EPSTEIN Aug. 1989 53 p
(Contract DAMD17-85-G-5044; DA PROJ. 3E1-62777-A-879)
(AD-A222599) Avail: NTIS HC A04/MF A01 CSCL 06/1

The Military Ergonomics Division at USARIEM has developed, based on their indoor laboratory studies, individual predictive equations for rectal temperature (Tre) and sweat loss (msw). These primary physiological inputs serve in a comprehensive model that predicts the expected physical work/rest cycle, the maximum single physical work time, and the associated water requirements. These predictive equations were studied in order to validate, and if necessary to adjust, and model for use under outdoor conditions with special reference to soldiers wearing CB protective garments. GRA

N90-26487# Navy Experimental Diving Unit, Panama City, FL.
ARCTIC COLD WEATHER MEDICINE AND ACCIDENTAL HYPOTHERMIA Final Report
JOHN A. STERBA Mar. 1990 31 p
(AD-A223090; NEDU-2-90) Avail: NTIS HC A03/MF A01 CSCL 06/5

Arctic ice camp diving operations require routine and emergency medical care to be provided by a U.S. Navy Corpsman trained as a Diving Medical Technician (DMT). This report will discuss common medical illnesses and injuries that occur in the Artic. It is based on a review of medical and operational literature and a recent deployment to the Artic. Topics discussed in this report include: cold acclimatization, recommendations for staying warm, conducting sick call and common medical problems such as dehydration, skin conditions, upper respiratory conditions, cold injuries including nonfreezing cold injury and frostbite, eye conditions, infectious diseases, psychological stresses, and common accidents and injuries encountered in the Artic. Due to much controversy in the medical and lay literature, the field treatment of hypothermia is discussed separately, reviewing both medical research and current treatment guidelines. GRA

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BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

A90-42663
PILOT - MENTAL AND PHYSICAL PERFORMANCE
DAVID C. EDWARDS (Iowa State University, Ames) Ames, IA, Iowa State University Press, 1990, 224 p. refs
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Physical and psychological factors affecting the performance of pilots are discussed; the treatment is general, but the emphasis is on the general-aviation case. Topics addressed include vision, hearing, and the equilibratory senses; perception in flight; perception of cockpit information; the psychology of aircraft controls; learning and memory; effective flight training; decision-making; reasoning, problem solving, and planning; and control of attention. Consideration is given to work load and time sharing, body responses to flying conditions, sleep and biological

rhythms, boredom and fatigue, stress and distress, psychopathology, and judgement and pilot error. T.K.

A90-43381#
AGE-RELATED CHANGES IN PERFORMANCE OF PILOTS
KYOICHI NAGATSUKA, YOSHINORI TAKEUCHI, and YUKO NAGASAWA Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 30, Sept. 1989, p. 35-44. In Japanese, with abstract in English. refs

Three performance tests, measuring fundamental aspects of piloting were imposed to 147 JASDF pilots in order to see the effects of aging. The tests were an attention distribution test to measure concentration and distribution of attention, a sensori-motor coordination test to measure tracking performance, and a short term-memory test to measure memory-span. Pilots in their 40s showed significant decreases of performance in the attention distribution test, and in the short-term memory test, as compared with those pilots who were in their 20s and 30s. No aging effect was seen in the sensori-motor coordination test which required the quick sensori-motor functions. Author

A90-43383#
PILOTS' LEARNING ABILITIES AND THEIR AGES IN AIRCRAFT TRANSITION TRAININGS. I - ANALYSIS OF FINAL GRADES IN TRANSITION TRAININGS
MIYAKO OKAUE and ZENJI TAKASHIMA Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 30, Sept. 1989, p. 65-76. In Japanese, with abstract in English. refs

Test results of pilots in transition courses are analyzed to determine which effect is greatest on pilot's learning, the decline of abilities with aging or the transfer of flying experience from previous aircraft assignments. When a pilot's total flight hours were correlated with his age, the ratings of the experienced older pilots were usually higher than those of the younger less experienced pilots. Where flight experience before the transition was about the same but ages were different, ratings and ages were not correlated, and older pilots did not show higher ratings. Where flight missions were different for new aircraft types, the learning abilities of pilots in mission flight training were inferior to those of pilots whose flight missions were almost the same between the new and prior assignments. R.E.P.

A90-43384#
PILOTS' LEARNING ABILITIES AND THEIR AGES IN AIRCRAFT TRANSITION TRAININGS. II - QUESTIONNAIRE SURVEY TO STUDENT PILOTS AND THEIR INSTRUCTORS IN TRANSITION TRAININGS
MIYAKO OKAUE and ZENJI TAKASHIMA Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 30, Sept. 1989, p. 77-92. In Japanese, with abstract in English. refs

A90-44629
THE EFFECTS OF ACOUSTIC ORIENTATION CUES ON INSTRUMENT FLIGHT PERFORMANCE IN A FLIGHT SIMULATOR
TERENCE J. LYONS, KENT K. GILLINGHAM, DON C. TEAS, WILLIAM R. ERCOLINE, and CAROLYN OAKLEY (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 699-706. refs
Copyright

An acoustic orientation instrument (AOI), in which airspeed was displayed as sound frequency, vertical velocity as amplitude modulation rate, and bank angle as right-left lateralization, was evaluated in a T-40 motion-based simulator. In this study, 15 pilots and 3 nonpilots were taught to use the AOI and flew simulated flight profiles under conditions of neither visual nor auditory instrumentation (NO INPUT), AOI signals only (AOI), T-40 instrumentation only (VISUAL), and T-40 instrumentation with AOI signals. Bank control under AOI was significantly better than under NO INPUT for all flying tasks. Bank control under VISUAL was significantly better than under AOI only during turning and when performing certain complex secondary tasks. The pilots' ability to use the AOI to control vertical velocity and airspeed was less apparent. However, during straight-and-level flight, turns, and descents, the AOI provided the pilots with sufficient information to maintain controlled flight. Author

A90-44642
IN SEARCH OF AN INHERENT ORDERING OF VOWEL PHONEMES, OR DO PILOTS HEAR LIKE ENGINEERS DO?
VALERIE J. GAWRON and DITMAR H. BOCK (Calspan Advanced Technology Center, Buffalo, NY) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 758-760. refs
Copyright

To test the hypothesis that formant frequencies might provide an inherent ordering scheme for vowel sounds, two groups of subjects were asked to place six Italian vowel phonemes (A, O, U, AE, E, and I) into the most musically pleasing order. A subsequent chi-sq analysis of selections of the first group (21 music students and engineers) indicated a reliable consistency in vowel order supporting the hyothesis. Analysis of the second group (12 pilots) did not indicate any consistent ordering. The results are discussed in terms of hearing damage associated with exposure to high-frequency aircraft noise. Author

N90-25486# Human Engineering Labs., Aberdeen Proving Ground, MD.
THE ROLE OF ATTENTION IN INFORMATION PROCESSING IMPLICATIONS FOR THE DESIGN OF DISPLAYS Final Report
LYNN C. OATMAN *Dec. 1989* 44 p
(Contract DA PROJ. 1L1-61102-B-74-A)
(AD-A219252; HEL-TN-14-89) Avail: NTIS HC A03/MF A01
CSCL 05/2

A principal goal in human factors engineering (HFE) is to develop a theoretical and empirical basis for matching the attentional mechanisms of the human operator with the appropriate information portrayed by the visual display. Since a display serves as an interface between the human operator and a dynamic system, its structure and composition are critical to the operator's performance. A display compatible with the human operator's attention mechanisms will improve performance by allowing faster, more accurate information processing, and will minimize mental work load. The system designer has to predict which attention mechanism an operator will use in a specific task situation. A very effective human-system interface will result if the designer succeeds in matching the displayed information with the appropriate attention mechanism. GRA

N90-25487# Eagle Technology, Inc., Winter Park, FL.
DEVELOPMENT OF A META-ANALYTIC TECHNIQUE TO ASSESS STRESS EFFECTS Final Technical Report, Sep. 1988 - Apr. 1989
JAMES E. DRISKELL, BRIAN MULLEN, and CHERYL L. BATCHELOR (Air Force Human Resources Lab., Wright-Patterson AFB, OH.) Mar. 1990 54 p Submitted for publication
(Contract F33615-88-C-0017; AF PROJ. 1710)
(AD-A220468; AFHRL-TP-89-19) Avail: NTIS HC A04/MF A01
CSCL 05/8

The true test of military systems and personnel is their ability to operate efficiently in the high stress combat environment. This is especially true in the field of combat maintenance, because the maintenance function is essential to maintaining the high rate of sorties required on the future battlefield. Yet maintenance personnel, although highly trained and skilled technicians, receive little preparation for the extreme stresses of the combat environment. The present effort takes a unique and innovative approach, utilizing a meta-analytic technique, to identify the stress factors that restrict or limit effective performance. Preliminary analyses examining the effects of time pressure, group pressure, and noise on performance indicate that this approach is technically sound and of significant practical value. GRA

N90-25488# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Hamburg (Germany, F.R.). Abt. Luft- und Raumfahrtpsychologie.
THE PREDICTION OF PROFESSIONAL SUCCESS OF LICENCED PILOTS: THE VALIDITY OF FLIGHT EXPERIENCE IN COMPARISON WITH STANDARDIZED PSYCHOLOGICAL APTITUDE TESTS
PETER MASCHKE and HANS-JUERGEN HOERMANN Aug. 1989 41 p In GERMAN; ENGLISH summary
(DLR-FB-89-53; ISSN-0171-1342; ETN-90-96457) Avail: NTIS HC A03/MF A01; DLR, VB-PL-DO, Postfach 40 60 58, 5000 Cologne, Fed. Republic of Germany, 15.50 DM

The predictive validities of a psychological aptitude test battery were determined in comparison with variables of flight experience. Rating obtained on a three level scale after the first line check served as the criterion. Univariate and multivariate statistical analyses revealed acceptable predictive validity for the psychological aptitude tests. In contrast, variables of flight experience did not contribute significantly to the prognosis of professional success. ESA

N90-25489# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Hamburg (Germany, F.R.). Abt. Luft- und Raumfahrtpsychologie.
STUDY OF THE APPLICATION OF A STRESS REACTIVITY TEST IN PERSONNEL SELECTION Ph.D. Thesis - Wuerzburg Univ.
MANFRED BARBARINO Jun. 1989 81 p In GERMAN; ENGLISH summary
(DLR-FB-89-54; ISSN-0171-1342; ETN-90-96458) Avail: NTIS HC A05/MF A01; DLR, VB-PL-DO, Postfach 40 60 58, 5000 Cologne, Fed. Republic of Germany, 27.50 DM

The application of reaction ability tests for personnel selection, designed to measure certain dimensions of personality, is discussed on the basis of an empirical study. The Tower of Hanoi was chosen as a reaction ability test in the context of German military pilot selection. The criteria for measuring reactions to stress include parameters of self-described feelings, coping strategies and psychological measures. Some parameters show the expected differences between control and experimental situation. Some selected reaction ability parameters prove to be sufficiently reliable and to correlate with other methods of the test battery. ESA

N90-25490# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Hamburg (Germany, F.R.). Abt. Luft- und Raumfahrtpsychologie.
TOM: TEST OF MULTIPLE TASK PERFORMANCE, USER MANUAL
HANS-JUERGEN HOERMANN, DIETRICH MANZEY, and GEORG H. FINELL Oct. 1989 48 p
(DLR-FB-89-60; ISSN-0171-1342; ETN-90-97010) Avail: NTIS HC A03/MF A01; DLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, 18.50 deutsche marks

The capability to cope with several tasks at the same time as one of the most important aptitude characteristics of pilots is addressed. In order to assess this basic capability, a computerized test of multiple task performance (TOM) was developed. This test consists of four independent tasks which are given to the subject on a monitor and which have to be performed simultaneously: two tracking tasks, one choice-reaction time task, and one mental arithmetic task. Details of test application (including standardized texts for an instruction of subjects to be tested), test evaluation, and some guidelines for an interpretation of the test results are described in detail. First empirical results which prove the reliability and the predictive validity of the test for the selection of (student) pilots are presented. ESA

N90-25491# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Hamburg (Germany, F.R.). Abt. Luft- und Raumfahrtpsychologie.
INTERNATIONAL APPLICATION OF THE DLR TEST-SYSTEM: FIRST YEAR OF COOPERATION WITH IBERIA IN PILOT SELECTION
DIETRICH MANZEY, HANS-JUERGEN HOERMANN, GABRIELE OSNABRUEGGE, and KLAUS-MARTIN GOETERS Jan. 1990 66 p
(DLR-FB-90-05; ISSN-0171-1342; ETN-90-97014) Avail: NTIS HC A04/MF A01; DLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, 24 deutsche marks

During the first year of cooperation between DLR (Department of Aviation and Space Psychology) and the Spanish flag carrier Iberia, a parallel version of the German DLR test-system for the selection of student pilots was developed and applied in Spain. The results of the first selection campaigns and the statistical evaluation of the tests are reported. Comparisons between different groups of applicants (German and Spanish applicants, male and female Spanish applicants) are made. ESA

N90-25492 Institute for Perception RVO-TNO, Soesterberg (Netherlands). Vision Group.
ON THE RELATION BETWEEN VARIOUS LEVELS OF TARGET ACQUISITION Final Report
J. J. IVOS Oct. 1989 16 p Sponsored by Royal Netherlands Army
(Contract A85/D/110)
(IZF-1989-38; TD-89-4139; ETN-90-96997) Copyright Avail: TNO Institute for Perception, P.O. Box 23, 3769 ZG Soesterberg, Netherlands

Laboratory target acquisition data were reanalyzed in order to determine the relation between different levels of target acquisition, such as detection, recognition and identification. It turns out that these levels essentially differ by a contrast difference in Z-probability score. Though the magnitude of the difference may differ, depending on the set of targets, an operational definition is proposed by Z(sub recognition) equal to Z(sub detection) - 0.5 and Z(sub identification) equal to Z(sub detection) - 1. This finding is very much at variance with the ACQUIR model of target acquisition. As a consequence detection, recognition and identification ranges are predicted to be far less different than predicted by ACQUIR. ESA

N90-25493 Institute for Perception RVO-TNO, Soesterberg (Netherlands).
PHIND, AN ANALYTICAL MODEL TO PREDICT TARGET ACQUISITION DISTANCE WITH IMAGE INTENSIFIERS Final Report
J. J. VOS and A. VANMEETEREN 23 Oct. 1989 29 p Sponsored by Royal Netherlands Army
(Contract A85/D/110)
(IZF-1989-45; TD-89-4144; ETN-90-96998) Copyright Avail: TNO Institute for Perception, P.O. Box 23, 3769 ZG Soesterberg, Netherlands

A calculation scheme to predict the visual range with image intensifiers is further elaborated and quantified. As a result a simple calculation program, PHIND, is produced in FORTRAN, or to be run on a hand calculator. In this program the physical characteristics of the image intensifier and the observation conditions (target size and contrast and the meteorological visual range) have to be introduced. It then calculates the recognition distance for any value of the vertical illuminance. The program was tested against a sizeable experimental data set. The recognition distance for widely varying targets could be described on the basis of realistic physical target contrasts with respect to background, and a characteristic size which may be related to typical background clutter. ESA

N90-25494# European Space Agency, Paris (France).
DIFFERENTIAL PSYCHOLOGICAL ANALYSIS OF A COMPUTER-BASED AUDIO-VISUAL TEST OF VIGILANCE
PETER MASCHKE and GEORG H. FINELL (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Hamburg, Germany, F.R.) May 1990 50 p Transl. into ENGLISH from Differentiellpsychologiche Analyse eines Computergesteuerten audiovisuellen Vigilanztests (Hamburg, Fed. Republic of Germany, DFVLR), May 1988 48 p Original language document was announced as N89-13140

(ESA-TT-1136; DFVLR-FB-88-23; ETN-90-97073) Avail: NTIS HC A03/MF A01

An audio-visual vigilance test in which visual signals (pointer deflections) and auditory (letter) signals are presented simultaneously is investigated with regard to its differential and diagnosic value. The test subject pool consisted of 261 applicants for work as airline pilots and 241 applicants for work as air traffic controllers. Correlational and factorial analyses with reference tests indicate the existence of two independent vigilance constructs: signal detection and false alarms. For both test subject pools, these characteristics are adequately reliable, both visually and auditorily. ESA

N90-25539*# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.

PERFORMANCE-BASED WORKLOAD ASSESSMENT: ALLOCATION STRATEGY AND ADDED TASK SENSITIVITY

MICHAEL A. VIDULICH *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 329-335 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 05/9

The preliminary results of a research program investigating the use of added tasks to evaluate mental workload are reviewed. The focus of the first studies was a reappraisal of the traditional secondary task logic that encouraged the use of low-priority instructions for the added task. It was believed that such low-priority tasks would encourage subjects to split their available resources among the two tasks. The primary task would be assigned all the resources it needed, and any remaining reserve capacity would be assigned to the secondary task. If the model were correct, this approach was expected to combine sensitivity to primary task difficulty with unintrusiveness to primary task performance. The first studies of the current project demonstrated that a high-priority added task, although intrusive, could be more sensitive than the traditional low-priority secondary task. These results suggested that a more appropriate model of the attentional effects associated with added task performance might be based on capacity switching, rather than the traditional optimal allocation model. Author

N90-25540*# Illinois Univ., Urbana-Champaign. Dept. of Psychology.

REAL-TIME MEASUREMENT OF MENTAL WORKLOAD: A FEASIBILITY STUDY

ARTHUR KRAMER, DARRYL HUMPHREY, ERIK SIREVAAG, and AXEL MECKLINGER *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 339-345 Mar. 1990

(Contract NAG2-308; N00014-89-J-1493)

Avail: NTIS HC A99/MF A04 CSCL 05/9

The primary goal of the study was to explore the utility of event-related brain potentials (ERP) as real-time measures of workload. To this end, subjects performed two different tasks both separately and together. One task required that subjects monitor a bank of constantly changing gauges and detect critical deviations. Difficulty was varied by changing the predictability of the gauges. The second task was mental arithmetic. Difficulty was varied by requiring subjects to perform operations on either two or three columns of numbers. Two conditions that could easily be distinguished on the basis of performance measures were selected for the real-time evaluation of ERPs. A bootstrapping approach was adopted in which one thousand samples of n trials (n = 1, 3, 5 ...65) were classified using several measures of P300 and Slow Wave amplitude. Classification accuracies of 85 percent were achieved with 25 trials. Results are discussed in terms of potential enhancements for real-time recording. Author

N90-26488*# Old Dominion Univ., Norfolk, VA. Dept. of Electrical and Computer Engineering.

INVESTIGATION OF AUTOMATED TASK LEARNING, DECOMPOSITION AND SCHEDULING Final Report, period ending 28 Feb. 1990

DAVID L. LIVINGSTON, GURSEL SERPEN, and CHANDRASHEKAR L. MASTI Jul. 1990 88 p

(Contract NAG1-962)

(NASA-CR-186791; NAS 1.26:186791) Avail: NTIS HC A05/MF A01 CSCL 05/9

The details and results of research conducted in the application of neural networks to task planning and decomposition are presented. Task planning and decomposition are operations that humans perform in a reasonably efficient manner. Without the use of good heuristics and usually much human interaction, automatic planners and decomposers generally do not perform well due to the intractable nature of the problems under consideration. The human-like performance of neural networks has shown promise for generating acceptable solutions to intractable problems such as planning and decomposition. This was the primary reasoning behind attempting the study. The basis for the work is the use of state machines to model tasks. State machine models provide a useful means for examining the structure of tasks since many formal techniques have been developed for their analysis and synthesis. It is the approach to integrate the strong algebraic foundations of state machines with the heretofore trial-and-error approach to neural network synthesis. Author

N90-26489# Universal Energy Systems, Inc., Dayton, OH.

THE RETRIEVAL OF INFORMATION FROM SECONDARY MEMORY: A REVIEW AND NEW FINDINGS Final Report, Sep. 1987 - Mar. 1988

DAVID L. STRAYER and ARTHUR F. KRAMER Dec. 1989 195 p

(Contract F33615-84-D-0505; AF PROJ. 2313)

(AD-A222760; AAMRL-TR-88-041) Avail: NTIS HC A09/MF A01 CSCL 05/8

Memory search was compared when the memorized items were either in primary or secondary memory. Distractor tasks were used to require secondary memory storage during a memory retrieval task. The additive effects of memory load and delay support the interpretation of separate retrieval and memory search processes. In a second experiment, event related potentials were used to examine the hypothesis that the increase in reaction time from primary to secondary memory was due to the insertion of a retrieval process prior to memory comparison. P300 latency data suggest that stimulus evaluation and response related processing are both affected by delay. GRA

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

A90-42700*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.

U.S. SPACE STATION FREEDOM WASTE FLUID DISPOSAL SYSTEM WITH CONSIDERATION OF HYDRAZINE WASTE GAS INJECTION THRUSTERS

BRIAN A. WINTERS (McDonnell Douglas Space Systems Co., Space Station Div., Huntington, Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 26th, Orlando, FL, July 16-18, 1990. 9 p. Research supported by NASA.

(AIAA PAPER 90-1944) Copyright

The results are reported of a study of various methods for propulsively disposing of waste gases. The options considered include hydrazine waste gas injection, resistojets, and eutectic salt phase change heat beds. An overview is given of the waste gas disposal system and how hydrozine waste gas injector thruster is implemented within it. Thruster performance for various gases are given and comparisons with currently available thruster models are made. The impact of disposal on station propellant requirements and electrical power usage are addressed. Contamination effects,

reliability and maintainability assessments, safety issues, and operational scenarios of the waste gas thruster and disposal system are considered. C.D.

A90-43155
PUSHING THE ENVELOPE - SPACE TELEROBOTICS AT CARNEGIE MELLON UNIVERSITY
CHRISTOPHER LOCKE (Carnegie-Mellon University, Pittsburgh, PA) IEEE Expert (ISSN 0885-9000), vol. 5, June 1990, p. 2-6. Copyright

Three space-oriented projects at the CMU Robotics Institute are described: the Ambler Planetary Rover, the self-mobile space manipulator, and the Hubble Space Telescope scheduling system. The Ambler Planetary Rover Project is a comprehensive research program to design and build an intelligent machine that will explore and sample extraterrestrial planetary surfaces. The self-mobile space manipulator robot is part of an effort to develop technologies that will enable mobile robots to be used on the Space Station and other space structures. The Hubble Space Telescope scheduling project is developing a software architecture to formulate and solve complex planning and scheduling problems. I.E.

A90-43156* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PLANNING FOR SPACE TELEROBOTICS - THE REMOTE MISSION SPECIALIST
MARK ROKEY and SVEN GRENANDER (JPL, Pasadena, CA) IEEE Expert (ISSN 0885-9000), vol. 5, June 1990, p. 8-15. refs Copyright

A brief history of planning research done by the group that produced the RMS (Remote Mission Specialist) planner is presented. Space telerobotics under study at JPL is then discussed, and RMS is described in detail. How RMS functions in an example execution is examined. The planner's capabilities are summarized, and possible future applications are suggested. I.E.

A90-43467* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A TELEROBOTIC SYSTEM FOR AUTOMATED ASSEMBLY OF LARGE SPACE STRUCTURES
MARVIN D. RHODES, RALPH W. WILL (NASA, Langley Research Center, Hampton, VA), and MARION A. WISE (PRC Kentron, Inc., Hampton, VA) IN: The 21st century in space; Proceedings of the Thirty-fifth Annual AAS Conference, Saint Louis, MO, Oct. 24-26, 1988. San Diego, CA, Univelt, Inc., 1990, p. 111-129. Previously announced in STAR as N89-21824.
(AAS PAPER 88-170) Copyright

Future space missions such as polar platforms and antennas are anticipated to require large truss structures as their primary support system. During the past several years considerable research has been conducted to develop hardware and construction techniques suitable for astronaut assembly of truss structures in space. A research program has recently been initiated to develop the technology and to demonstrate the potential for automated in-space assembly of large erectable structures. The initial effort will be focused on automated assembly of a tetrahedral truss composed of 2-meter members. The facility is designed as a ground based system to permit evaluation of assembly concepts and was not designed for space qualification. The system is intended to be used as a tool from which more sophisticated procedures and operations can be developed. The facility description includes a truss structure, motionbases and a robot arm equipped with an end effector. Other considerations and requirements of the structural assembly describe computer control systems to monitor and control the operations of the assembly facility. Author

A90-43469
THE 21ST CENTURY IN SPACE: FUTURE ROBOTIC TECHNOLOGIES - AN INDUSTRIAL RESEARCHER'S VIEW
STEPHEN J. BARTHOLET (Odetics, Inc., Anaheim, CA) IN: The 21st century in space; Proceedings of the Thirty-fifth Annual AAS Conference, Saint Louis, MO, Oct. 24-26, 1988. San Diego, CA, Univelt, Inc., 1990, p. 157-163.
(AAS PAPER 88-183) Copyright

A narrow segment of robotic technologies that is crucial to many space applications is considered, namely machine vision derived from direct three-dimensional imaging sensors. Consideration is given to the machine interpretation of imaging sensor data and the impact of this interpretation on the distribution of information and control. The particular focus is on laser range imagers, which play a significant role because the data produced by them is inherently machine-friendly and their hardware technology is space-qualifiable in the near term. Particular attention is given to the use of the Odetics Laser Imaging Radar in the NASA EVA Retriever Project. B.J.

A90-43470
AN ASSESSMENT OF THE DEVELOPMENT AND APPLICATION POTENTIAL FOR ROBOTS TO SUPPORT SPACE STATION OPERATIONS
DELBERT TESAR (Texas, University, Austin) IN: The 21st century in space; Proceedings of the Thirty-fifth Annual AAS Conference, Saint Louis, MO, Oct. 24-26, 1988. San Diego, CA, Univelt, Inc., 1990, p. 165-208. refs
(AAS PAPER 88-184) Copyright

It is suggested that the top seven long-term robotics component priorities for the Space Station are: man-machine interface, end effectors, actuator modules, sensor technology, computer architecture, graphics, CAD, and intelligent control. It is further suggested that the progress of a major national robotics program must be measured in terms of a finite number of system criteria for the operation of robotics in the Space Station. The top seven long-term criteria are: multiple task capability, level of machine intelligence, precision, portability and mobility, reliability, obstacle avoidance, and force sensing. A matrix analysis for these priorities indicates that no one component technology or system criterion can solve the mission needs of Space Station robotics. Instead, what is critically needed is a balanced development of all component technologies and system criteria in proportion to the demonstrated needs derived from a careful functional analysis. B.J.

A90-44151
MINIMUM RESOLVABLE TEMPERATURE PREDICTIONS, TEST METHODOLOGY, AND DATA ANALYSIS
GERALD C. HOLST (Martin Marietta Electronic Systems, Orlando, FL) IN: Infrared technology XV; Proceedings of the Meeting, San Diego, CA, Aug. 7-9, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 208-218. refs Copyright

The Night Vision Laboratory model has proven unable to predict the minimum resolvable temperature (MRT) values at either low or high spatial frequency due to poor eye modeling, observer variability, and a poorly defined data analysis methodology. An automated procedure based on head movement has been developed which matches measured values, yielding an objective MRT which is proportional to the noise-equivalent differential temperature and inversely proportional to the modulation transfer function of the system. An observer remains essential for furnishing a final decision as to the acceptability of quality. O.C.

A90-44553#
DEVELOPMENT OF LOCAL LIQUID COOLING GARMENT
GUOJIE DU, SHENRAN GE, and ZIYUAN LIN (Institute of Space Medico-Engineering, Beijing, People's Republic of China) Chinese Space Science and Technology (ISSN 1000-758X), vol. 9, Feb. 1989, p. 13-23. In Chinese, with abstract in English. refs

This paper systematically describes the design, pattern technology methodology characteristics, and functional features of a local liquid cooling garment. Experimental test results on the garment are reported. C.D.

A90-44641* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EFFECTIVENESS OF THE SPACE SHUTTLE ANTI-EXPOSURE SYSTEM IN A COLD WATER ENVIRONMENT
JAMES P. BAGIAN (NASA, Johnson Space Center, Houston, TX) and JONATHAN W. KAUFMAN (U.S. Navy, Naval Air Development Center, Warminster, PA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Aug. 1990, p. 753-757. refs
Copyright

The purpose of this study was to evaluate the NASA Space Shuttle launch entry suit (LES) and raft for 24 h of protection against cold water immersion. Two configurations, the LES and the LES with raft (LES/r) were evaluated for antiexposure protection. Conditions were selected to simulate worst-case water and air temperatures along projected Space Shuttle ground tracks; i.e., water temperatures = 4.4 C, air temperature = 5.6 C, 1-foot waves (chop), and constant spray. Four males 31-44 years of age and one 32-year-old female were studied once in each configuration. Trials with and without a raft were scheduled for up to 24 and 6 h, respectively. Mean LES trial durations were 150 + or - 9 min and final rectal temperature (FRT) = 36.5 + or - 0.3 C. Mean LES/r trial durations were 398 + or - 126 min and FRT = 35.6 + or - 0.4 C. LES and LES/r trials were terminated for reaching FRT = 35.0 C or subject-requested termination due to discomfort. The longest LES and LES/r trials were terminated due to subject discomfort. Although not achieving the desired durations, the LES and LES/r did prove capable of protecting individuals, respectively, for up to 3 and 13.5 h. Since the longest runs were terminated due to subjective tolerance, actual survival times greater than 3 and 13.5 h could be expected. Author

A90-44651
HIGH ALTITUDE PROTECTIVE EQUIPMENT - A REVIEW OF PRESSURE SYSTEMS
WILLIAM J. SEARS Aeromedical and Training Digest (ISSN 0001-9275), vol. 4, Jan. 1990, p. 2-6. refs
Copyright

The effects of loss of cabin pressure at high altitudes are described. It is pointed out that the ideal pressurized garment would provide a balance of adequate protection following loss of cabin pressure and minimal reduction in flying efficiency. Various methods of restoring pressurization to all or part of the body are discussed including encapsulated seat or escape modules, passive pressurization, capstan tubes, bladders, and full pressure suits. The advantages of a combination of direct gas loading and bladder protection are examined. The general criteria, including specific psychological criteria, that have been established on an international basis and that establish acceptable protection for aircrew at altitudes above 50,000 feet are reviewed. Garment and equipment design are discussed including single layer and modular suit construction, sizing, fabrics, and pressure control and oxygen systems. L.K.S.

A90-44906
METHOD FOR THE REALIZATION OF AUTONOMY AND STATIONARITY PRINCIPLES IN THE SYNTHESIS OF ERGATIC SYSTEMS [METOD REALIZATSII PRINTSIPOV AVTONOMNOSTI I STATSIONARNOSTI PRI SINTEZE ERGATICHESKIKH SISTEM]
N. S. SIVOV and A. V. KHARCHENKO (Kievskoe Vysshee Voennoe Aviatsionnoe Inzhenernoe Uchilishche, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 84, 1989, p. 51-53. In Russian.
Copyright

A method for the synthesis of ergatic systems (i.e., systems with a human operator in the control loop) is proposed. The method is based on providing the complex nonstationary plant with stationarity and autonomy, properties that are desirable from the viewpoint of the human operator. The synthesized algorithm is fully adaptive. B.J.

A90-44907
EVALUATION OF THE EFFECT OF PILOT ERRORS ON FLIGHT SAFETY [OTSENKA VLIIANIIA OSHIBOK EKIPAZHA NA BEZOPASNOST' POLETOV]
V. N. GOLEGO (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 84, 1989, p. 81-88. In Russian.
Copyright

The effects of pilot error are evaluated on the basis of a set of criteria computed from statistical data on the incidence of accidents in civil aviation using a multifactor error model. The measure of the hazard associated with an error is the conditional probability of its occurrence in accordance with the elements of the model. A comparative analysis of the indices of the criteria makes it possible to identify the dominant group of errors, having the most significant effect on flight safety. A combined criterion is proposed which takes into account in an additive form all types of accidents and incidents. B.J.

A90-44908
PRINCIPLES OF VARIABILITY IN THE CONTROL OF THE PRECISION MOVEMENTS OF HUMANS [PRICHINY VARIATIVNOSTI PRI UPRAVLENII TOCHNOSTNYMI DVIZHENIIAMI CHELOVEKA]
V. G. TKACHUK (Kievskii Gosudarstvennyi Institut Fizicheskoi Kul'tury, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 84, 1989, p. 88-93. In Russian. refs
Copyright

Data on causes of the variability of the spatial, force, and temporal characteristics of the precision movements of humans have been analyzed. The variability phenomenon is considered as a property of biological control systems having a hierarchical organizational structure at all levels of organismic activity. Exogenic and endogenic factors involved in the variability are shown, and regression models of this phenomenon are presented. B.J.

A90-44909
ERGONOMIC SUPPORT OF AIRCRAFT DEVELOPMENT PROCESSES [ERGONOMICHESKOE OBESPECHENIE PROTSESSOV RAZRABOTKI LETATEL'NYKH APPARATOV]
V. B. TARASOV and A. P. CHERNYSHEV (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 84, 1989, p. 96-102. In Russian. refs
Copyright

Theoretical and methodological aspects of the ergonomic (human factors) support of aircraft development processes are examined. The necessity of taking the human factor into account in the computer-aided design of aircraft is established, and ways to do this are suggested. B.J.

A90-45201 Kaiser Electronics, San Jose, CA.
HELMET-MOUNTED DISPLAYS; PROCEEDINGS OF THE MEETING, ORLANDO, FL, MAR. 28, 29, 1989
JEROME T. CAROLLO, ED. (Kaiser Electronics, San Jose, CA) Meeting sponsored by SPIE, New Mexico State University, JPL, et al. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 1116), 1989, 216 p. For individual items see A90-45202 to A90-45222.
(SPIE-1116) Copyright

The latest applications of helmet-mounted display (HMD) optical systems are examined, with focus placed on tactical aircraft, rotorcraft, simulators, space applications, and land vehicles. The conference opens with the patent description of a helmet integrated system dating back to World War I and continues with such topics as a tilted catadioptric HMD, optical approaches to HMDs, visually coupled system integration, and digital image processing for HMDs. Photography-based image generation, a helmet-mounted laser projection display, and fiber-optic developments are covered, along with helmet integration, ocular responses to monocular and binocular HMD configurations for tactical aircraft. The performance

of night-vision devices, the dynamic response of an electrooptical imaging system, and the restoration of motion-degraded images in electrooptical displays are also discussed. V.T.

A90-45202
BACK FROM THE PAST - THE HELMET INTEGRATED SYSTEM OF ALBERT BACON PRATT (1916)
GERALD F. MARSHALL IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 2-11.
Copyright
The concept of an integrated helmet-mounted aiming and weapon delivery system for a marksman as presented in Pratt's U.S. patent description is discussed, with emphasis on construction, size and fit, and the comfort of the wearer. The mechanism of the custom-designed gun mounted under the crown of the helmet is addressed, and attention is given to spent shells, reloading, and maintenance. A trigger device and trigger guard are covered, along with two alternative trigger devices. Alignment of the helmet and target acquisition are considered, and human factors are outlined, including the approach used to minimize recoil. V.T.

A90-45203
OPTICAL APPROACHES TO THE HELMET MOUNTED DISPLAY
DONALD J. ROTIER (Honeywell, Inc., Saint Louis Park, MN) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 14-18.
Copyright
Early designs for helmet-mounted displays utilizing a flat or unpowered combiner surface are outlined, and it is noted that this method still has advantages where simplicity and cost are important, and the field-of-view requirement is moderate. Rotationally symmetric and nonsymmetric geometries are discussed, and it is noted that nonsymmetrical or off-axis optical systems are widespread in the advanced helmet-mounted displays. The Tilted Cat design is addressed as an example of a display with a moderate fold angle, and then displays utilizing a visor as the combiner surface are assessed. A combiner structure of transparent material is analyzed as an alternative approach to achieving minimum obstruction, and a monolithic afocal relay combiner geometry is presented. V.T.

A90-45204
HELMET-MOUNTED DISPLAYS FOR HELICOPTER PILOTAGE - DESIGN CONFIGURATION TRADE-OFFS, ANALYSES, AND TEST
ROBERT A. LOHMANN and ALEXANDER Z. WEISZ (Hughes Aircraft Display Systems Laboratory, Los Angeles, CA) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 27-32.
Copyright
A helmet-mounted display combining the functions of display presentation with the head and facial protection is described. Human engineering factors applicable to the design of helmet-mounted displays for use with night-vision sensors are assessed, including operational stability, acceptance by the pilot community, crew training requirements, flight safety, and flight control workload. Attention is focused on biocular displays, FOV/resolution trade-offs, single- versus dual-CRT configurations, day operation and visual meteorological condition operation, and CRT dynamic range utilization. It is concluded that the designer should avoid introducing design features interfering with the visual search or perceptual habits. V.T.

A90-45205
VISUALLY COUPLED SYSTEM INTEGRATION
ROBERT M. THOMAS (Honeywell, Inc., Saint Louis Park, MN) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 33-36.
Copyright
Visually coupled systems (VCSs) integrating helmet trackers, helmet displays, helmets, sensors, weapons, and vehicles are considered, and their components, interfaces, and features are described. Integration requirements and compatibility factors for the components are discussed. Four configurations of integrated helmets including an 80-deg-horizontal-FOV binocular display, a 20-deg-FOV binocular visor projection display, a 30-deg-FOV binocular display system with integrated image intensification binocular, and a 40-deg monocular display with an integrated image-intensification monocular are presented. A specific VCS, its components, and interfaces are illustrated. V.T.

A90-45206
HELMET MOUNTED DISPLAYS AND THE EMERGING ATTACK ROTORCRAFT COUNTERAIR MISSION
JON S. TATRO and ROBERT R. TAYLOR (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 37-46. refs
Copyright
The air-to-air and counterair mission for future attack rotorcraft is considered, and the implications for crew-station design requirements are examined, with emphasis on 'eyes out' display and control technologies. Requirements for the offensive and defensive counterair missions (OCA and DCA) are outlined, and the active DCA mission is selected for an example scenario since it includes the battlefield elements that drive both mission equipment package and crew-station design requirements. Findings from a review of flight test data and pilot reports are discussed, focusing on HMD weight and weapons aiming and on HMD field of view. It is noted that computer-generated visual systems for aircraft simulation studies can be employed to extend the FOV-restricting methodology to the counterair HMD FOV issue. In addition, HMD symbology development and presentation techniques are assessed. V.T.

A90-45207
DIGITAL IMAGE PROCESSING OVERVIEW FOR HELMET MOUNTED DISPLAYS
MICHAEL J. PARISE (Honeywell, Inc., Saint Louis Park, MN) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 47-50.
Copyright
Multisensor fusion involving the combining of images from more than one sensor source for display as a single image is discussed. In the framework of this approach, pilot workload reduction is assessed, and a method providing the pilot with visual information in the aircraft without forward-looking windows or with poor landing visibility is proposed. The ability to manipulate an image by utilizing digital image processing technologies is also discussed, with emphasis on image enhancement and single-sensor three-dimensional imaging. V.T.

A90-45208
HARDWARE IMPROVEMENTS TO THE HELMET MOUNTED PROJECTOR ON THE VISUAL DISPLAY RESEARCH TOOL (VDRT) AT THE NAVAL TRAINING SYSTEMS CENTER
DICK BURBIDGE and PAUL M. MURRAY (Rediffusion Simulation, Ltd., Crawley, England) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 52-60.
(Contract N61339-82-O-0096; N61339-88-R-0042)
Copyright
The Visual Display Research Tool includes a helmet mounted projector for the display of flight simulation Area-of-Interest imagery on a 10-foot radius dome. The imagery is transmitted to the helmet using two coherent fiber optic ribbons. Some improvements have

been made to the fiber optic system and to the helmet fit. The imagery is head and eye slaved and the concepts for image positioning and stabilization are described. Author

A90-45209
PHOTO BASED IMAGE GENERATOR
NICHOLAS M. DALTON and CHARLES S. DEERING (LTV Missiles and Electronics Group, Dallas, TX) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 61-75.
Copyright

A two-channel photography-based image generator system developed to drive helmet-mounted laser projector is presented. The system generates a wide-FOV simulation with high resolution in the direction of gaze by utilizing a fiber-optic laser projector mounted on the pilot's helmet. A photo-based concept used in the system employs an array of still color photographic images. As the pilot flies over the gaming area, individual scenes are retrieved by the system; within each scene, two dynamic transformations are occurring simultaneously - one produces the wide-FOV image, while the other produces the narrow-FOV image. The system components are described, including the laser projector, image generator, video disk player, video digitizer, scene storage system, cell processors, and image-generation system computer. System installation and operation are briefly discussed, as well as its performance. V.T.

A90-45210
A HELMET MOUNTED DISPLAY APPLICATION FOR THE SPACE STATION FREEDOM EXTRAVEHICULAR MOBILITY UNIT
CONSTANCE L. TRITSCH (Lockheed Engineering and Sciences Co., Houston, TX) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 76-79. refs
Copyright

Several designs evolved in the development of the helmet-mounted display for the Space Station EVA mobility unit involved in extravehicular activity are reviewed, including a binocular pupil-forming system with two CRT image sources, a binocular system utilizing LCD image sources, and two designs employing conventional and holographic optics. Key design parameters, such as image/illumination sources, field of view, exit-pupil versus nonpupil forming systems, and monocular versus binocular and biocular systems. The degree of image overlap and the use of holographic optical elements are also assessed. V.T.

A90-45211
A HELMET-MOUNTED VIRTUAL ENVIRONMENT DISPLAY SYSTEM
ROBERT K. REBO and PHIL AMBURN (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 80-84. Research supported by USAF. refs
Copyright

A simple inexpensive helmet-mounted color display system with stereo capability utilizing off-shelf components is presented. The helmet-mounted display hardware consisting of the helmet mount, LCD displays, display optics, and the position tracker are described. Attention is focused on depth perception, the display algorithm, and Kalman filter. Test results indicate that the image display update rate is approximately 10/sec; as the polygon count in the displayed image increases, the time required to redraw the display slows. It is concluded that, as faster display hardware becomes available, more complex images can be displayed in full color and shaded in real time. V.T.

A90-45212
EVALUATION OF A HELMET-MOUNTED LASER PROJECTOR DISPLAY
G. BLAIR BROWDER (U.S. Navy, Naval Training Systems Center, Orlando, FL) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 85-89.
Copyright

The Visual Display Research Tool (VDRT) is a visual research test bed designed for the evaluation of the feasibility of an eye-slaved area-of-interest display that features a helmet-mounted laser projector. The VDRT, located at the Navy's Visual Technology Research Simulator, has been evaluated by experienced Navy pilots and found to be a feasible solution to satisfying the demanding requirements for a flight simulator with a very large field-of-view and high scene fidelity. Author

A90-45213
EYE TRACKER DEVELOPMENT ON THE FIBER OPTIC HELMET MOUNTED DISPLAY
RICHARD M. ROBINSON, MELVIN L. THOMAS (USAF, Human Resources Laboratory, Williams AFB, AZ), and PAUL A. WETZEL (Dayton, University, Higley, AZ) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 102-108.
(Contract F33615-81-C-0012)
Copyright

Requirements necessary for successful eye tracking in aircraft simulators are covered, and two approaches to monitoring eye position are presented. An eye position monitor for the fiber-optic helmet-mounted display (FOHMD) is described, along with two devices under development - dark-pupil and bright-pupil oculometers. Focus is placed on the investigation of saccadic suppression, eye movement prediction, and visual acuity in a dynamic rather than static environment. In the current application of the eye position monitor in the FOHMD, the algorithms applied to the eye position data correct the problems associated with eye blinks, eye tracker loss of signal, and rapid changes in pupil size. It is shown that either a dark- or a bright-pupil method of imaging the eye is reliable. V.T.

A90-45214
THE EFFECT OF INSTANTANEOUS FIELD OF VIEW SIZE ON THE ACQUISITION OF LOW LEVEL FLIGHT AND 30-DEG MANUAL DIVE BOMBING TASKS
KEVIN W. DIXON, GRETCHEN M. KRUEGER, VICTORIA A. ROJAS, and DAVID C. HUBBARD (USAF, Human Resources Laboratory, Williams AFB, AZ) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 110-121.
Copyright

The effect of various instantaneous field-of-view sizes on the performance of low-level flight and 30-deg manual dive bomb tasks is investigated with an in-simulator transfer of training design. The field-of-view sizes used are 127 deg H x 67 deg V, 140 deg H x 80 deg V, 160 deg H x 80 deg V, and 180 deg H x 80 deg V. Two significant univariate effects are found for the FOV interaction in the trial data. There is one significant univariate effect for mean pitch in the dive bomb testing phase, and the data obtained from questionnaires indicate that subjects felt they used out-of-the-window visual clues 15-20 percent more in the full-FOV test condition. It is recommended that a minimum instantaneous FOV of 160 deg H x 80 deg V be used to train pilots for low-level flight and manual dive bombing. V.T.

A90-45215
HELMET INTEGRATION - AN OVERVIEW OF CRITICAL ISSUES
ROBERT J. WHITCRAFT (Honeywell, Inc., Saint Louis Park, MN) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 122-125.
Copyright

Basic helmet-mounted sight/display (HMS/D) objectives for

tactical aircraft are reviewed, including performance, functional, and safety objectives. Attention is drawn to a fine line between capability and liability in the integration process. It is noted that the accuracy with which general parameters are applied for every aircraft type, every mission, and every crew configuration will signify either HMS/D system capability or liability. Tactical-aircraft integration issues, specifically for air-to-air missions are covered, and a sound integration approach at the beginning of a concept selection is emphasized. V.T.

A90-45216
UTILITY EVALUATION OF A HELMET-MOUNTED DISPLAY AND SIGHT
CHRISTOPHER J. ARBAK (McDonnell Douglas Corp., Saint Louis, MO) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 138-141.

Evaluation testing of a helmet-mounted display and sight (HMDS) system utilizing a magnetic sensor embedded in a helmet to detect head movement and presenting information tailored to the current head position on the helmet visor is described, and the results obtained are discussed. Four pilots evaluated the HMDS in 100 simulated air combat engagements against both manned and computer-controlled threats. The information obtained include subjective pilot workload data; performance data pertaining to changes in weapon employment, sensor usage, and mission success; and pilot comments. It is concluded that a combination of three factors - (1) the pilots learning to use the HMDS, (2) adapting the HMDS pilot vehicle interface to the individual pilot, and (3) letting the pilots choose their preferred helmet and cockpit - can be a significant tactical factor. V.T.

A90-45217
OCULAR RESPONSES TO MONOCULAR AND BINOCULAR HELMET-MOUNTED DISPLAY CONFIGURATIONS
KIRK MOFFITT (Kaiser Electronics, San Jose, CA) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 142-148. refs

Ocular vergence and visual-accommodation data were collected in a preliminary investigation involving simulated monocular and binocular helmet-mounted display (HMD) configurations with varying scenic backgrounds and attentional instructions. A binocular eyetracking system was used to objectively measure vergence and accommodation. Photographic slides aligned and positioned at optical infinity were used to simulate HMD symbology and out-of-the-cockpit scenery. The accuracy of ocular vergence and the relative distance of visual accommodation were affected by the HMD configuration (binocular, monocular, one-eye-occluded), the content of the scenic background (clouds or mountains), the focus of attention (symbology or background), and the ocular characteristics of the observer (distance of the dark-vergence and -focus). Author

A90-45218
TACTICAL APPLICATIONS OF THE HELMET DISPLAY IN FIGHTER AIRCRAFT
WILLIAM J. BARNES (Air National Guard Air Force Reserve Test Center, Tucson, AZ) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 149-160.

The tactical applications of current-technology helmet-mounted display (HMD) systems in fighter aircraft such as the F-15 and F-16 are discussed. Three major operational areas are covered: air-to-air, air-to-ground, and defense suppression. Each area is briefly outlined, and a generic profile of current capabilities is assessed, with attention drawn to such area components as attack, egress, and ingress phases. Focus is placed on expanded capabilities provided by HMD systems, as well as the requirements for an optimum system interfacing with a digital intra/interflight data link and an onboard threat-warning system. Emphasis is placed on potential uses of HMD systems from an operator's point of view, covering human-factor requirements and the types of information required by the pilot. The merits and liabilities of basic design requirements for operational HMD systems are discussed. V.T.

A90-45219
PREDICTING THE PERFORMANCE OF NIGHT VISION DEVICES USING A SIMPLE CONTRAST MODEL
WILLIAM M. DECKER (U.S. Army, Center for Night Vision and Electro-Optics, Fort Belvoir, VA) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 162-169. refs

A spreadsheet model producing spectral transmission curves and computing the apparent contrast for night-vision devices is considered. The program retrieves the necessary data, calculates a relative intensity for both the target and background, produces graphic displays, and calculates the contrast. Target and background measurements and atmospheric transmission data necessary for the model's data base are described, along with data acquisition and processing. In addition, data files for the various sky irradiance sources are outlined, and target and background reflectivity files as well as atmospheric attenuation and filter transmission files are covered. A sample of the relative response curves is also presented. V.T.

A90-45220
POLYCARBONATE OPTHTALMIC LENSES AND NIGHT VISION GOGGLES IN U.S. ARMY AVIATION
JOHN K. CROSLEY (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, AL) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 176-184. refs

The relative impact resistance of glass, CR-39 (plastic), and polycarbonate lenses utilized in night vision goggles (NVGs) is investigated, along with the acceptability of the polycarbonate lenses in the Army aviation environment. Drop-test results demonstrated that polycarbonate lenses have the superior ability of reducing the potential for eye injury when wearing NVGs. It is noted that in approximately 50 percent of the drop tests in which one or both of the lenses survived, lens dislodgment occurred. Acceptance of the polycarbonate lenses by Army aviators participating in the field test is reported to be excellent, with 92 percent stating that they were equal or superior to their regular-issue glass lenses, and 84 percent reporting no problem with scratching. V.T.

A90-45222
RESTORATION OF MOTION-DEGRADED IMAGES IN ELECTRO-OPTICAL DISPLAYS
A. K. CHERRI, A. A. S. AWWAL, M. A. KARIM, and D. L. MOON (Dayton, University, OH) IN: Helmet-mounted displays; Proceedings of the Meeting, Orlando, FL, Mar. 28, 29, 1989. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1989, p. 198-208. refs

Effects of the dynamic transfer function on the image quality as well as on the performance of electrooptical displays are discussed. The spatial-temporal transfer function of an imaging system is derived, and time-constant and spatial-speed calculations are performed. Computer simulation for image degradation is addressed, and degradation and restoration models are considered. It is shown that, by incorporating the concept of temporal response, it is possible to quantify degradation of the output image of an electrooptical display; this quantification can be employed in real-time techniques for restoration of motion-degraded images. V.T.

A90-45240
TILTED CAT HELMET-MOUNTED DISPLAY
JUSTIN G. DROESSLER and DONALD J. ROTIER (Honeywell Systems and Research Center, Minneapolis, MN) Optical Engineering (ISSN 0091-3286), vol. 29, Aug. 1990, p. 849-854.
Copyright

The present helmet-mounted display (HMD) employs a tilted catadioptric combiner display which allows a wide field-of-view (FOV) to possess 3:1 display brightness and combiner see-through transmission improvements over the conventional, folded-catadioptric HMD configuration. The tilted catadioptric combiner allows a practical display optical system to be defined for a 60-deg FOV; resolution is limited only by the resolution of the CRT employed. Attention is given to tangential and sagittal ray fan plots obtained for 12 field angles of a 10-mm pupil, as well as geometrical MTF plots for both 4-mm and 10-mm pupils. O.C.

A90-45242
COMPATIBILITY OF AIRCRAFT COCKPIT LIGHTING AND IMAGE INTENSIFICATION NIGHT IMAGING SYSTEMS
CLARENCE E. RASH (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, AL) and ROBERT W. VERONA (U.S. Army, Center for Night Vision and Electro-Optics, Fort Belvoir, VA) Optical Engineering (ISSN 0091-3286), vol. 29, Aug. 1990, p. 863-869. refs
Copyright

The performance of military night vision-imaging systems (NVISs) employing image-intensification tubes is subject to deterioration by the presence of cockpit light sources such as instrument lamps and caution lights. These lights activate the automatic gain control circuits of the intensification tubes, thereby reducing their sensitivity to external illumination. The triservice MIL-L-85762 specification of 1986 defines the measurement instrumentation and methods required for the certification of lighting components as 'NVIS-compatible'; the characterization of lighting incompatibilities in U.S. Army aircraft, the modification of lighting in NVIS-incompatible cockpits, and the certification of proposed lighting components, are all being conducted under MIL-L-85762 guidelines. O.C.

A90-45243
PERFORMANCE AND HEAD MOVEMENTS USING A HELMET-MOUNTED DISPLAY WITH DIFFERENT FIELDS-OF-VIEW
MAXWELL J. WELLS (Logicon Technical Services, Inc., Dayton, OH) and MICHAEL VENTURINO (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) Optical Engineering (ISSN 0091-3286), vol. 29, Aug. 1990, p. 870-877. refs
Copyright

In the present performance test trials for head-mounted displays (HMDs), 17 subjects detected, and then monitored, three, six, or nine stationary targets in order to destroy three simulated threats. The HMDs used made available five different field-of-view (FOV) sizes, ranging in width from 20 to 120 deg. Subjects are noted to have destroyed fewer threats, and to have been threatened for longer durations, with small FOVs rather than with large ones; the decrement in performance was dependent on the number of targets. Subjects moved their heads less, but did so faster, with large FOVs than with small ones. An apparent inverse relationship exists between head velocity during task performance and error at replacing the targets afterward: head velocity seems to be mediated by the certainty with which subjects recalled target locations. O.C.

N90-25495*# Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
MAN-MACHINE INTERFACE FOR THE CONTROL OF A LUNAR TRANSPORT MACHINE
RICHARD ASHLEY, LORING BACON, SCOTT TIM CARLTON, MARK MAY, JIMMY MOORE, and DENNIS PEEK 25 Aug. 1987 95 p
(Contract NGT-21-002-800)
(NASA-CR-184935; NAS 1.26:184935; ME-4182) Avail: NTIS HC A05/MF A01 CSCL 05/8

A proposed first generation human interface control panel is described which will be used to control SKITTER, a three-legged lunar walking machine. Under development at Georgia Tech, SKITTER will be a multi-purpose, un-manned vehicle capable of preparing a site for the proposed lunar base in advance of the arrival of men. This walking machine will be able to accept modular special purpose tools, such as a crane, a core sampling drill, and a digging device, among others. The project was concerned with the design of a human interface which could be used, from earth, to control the movements of SKITTER on the lunar surface. Preliminary inquiries were also made into necessary modifications required to adapt the panel to both a shirt-sleeve lunar environment and to a mobile unit which could be used by a man in a space suit at a lunar work site. Author

N90-25496*# Texas Univ., Austin. Dept. of Mechanical Engineering.
DESIGN OF A DEVICE TO REMOVE LUNAR DUST FROM SPACE SUITS FOR THE PROPOSED LUNAR BASE
DAVID HARRINGTON, JACK HAVENS, and DANIEL HESTER 1990 117 p
(Contract NASW-4435)
(NASA-CR-186679; NAS 1.26:186679) Avail: NTIS HC A06/MF A01 CSCL 06/11

The National Aeronautics and Space Administration plans to begin construction of a lunar base soon after the turn of the century. During the Apollo missions, lunar dust proved to be a problem because the dust adhered to all exposed material surfaces. Since lunar dust will be a problem during the establishment and operation of this base, the need exists for a device to remove the dust from space suits before the astronauts enter clean environments. The physical properties of lunar dust were characterized and energy methods for removing the dust were identified. Eight alternate designs were developed to remove the dust. The final design uses a brush and gas jet to remove the dust. The brush bristles are made from Kevlar fibers and the gas jet uses pressurized carbon dioxide from a portable tank. A throttling valve allows variable gas flow. Also, the tank is insulated with Kapton and electrically heated to prevent condensation of the carbon dioxide when the tank is exposed to the cold (- 240 F) lunar night. Author

N90-25497*# Florida Technological Univ., Orlando. Dept. of Aerospace Engineering.
DESIGN AND IMPLEMENTATION OF SENSOR SYSTEMS FOR CONTROL OF A CLOSED-LOOP LIFE SUPPORT SYSTEM
LESLIE ALNWICK, AMY CLARK, PATRICIA DEBS, CHRIS FRANCZEK, TOM GOOD, and PEDRO RODRIGUES Dec. 1989 121 p
(Contract NASW-4435)
(NASA-CR-186675; NAS 1.26:186675) Avail: NTIS HC A06/MF A01 CSCL 06/11

The sensing and controlling needs for a Closed-Loop Life Support System (CLLSS) were investigated. The sensing needs were identified in five particular areas and the requirements were defined for workable sensors. The specific areas of interest were atmosphere and temperature, nutrient delivery, plant health, plant propagation and support, and solids processing. The investigation of atmosphere and temperature control focused on the temperature distribution within the growth chamber as well as the possibility for sensing other parameters such as gas concentration, pressure, and humidity. The sensing needs were studied for monitoring the solution level in a porous membrane material along with the requirements for measuring the mass flow rate in the delivery system. The causes and symptoms of plant disease were examined and the various techniques for sensing these health indicators were explored. The study of sensing needs for plant propagation and support focused on monitoring seed viability and measuring seed moisture content as well as defining the requirements for drying and storing the seeds. The areas of harvesting, food

processing, and resource recycling, were covered with a main focus on the sensing possibilities for regulating the recycling process. Author

N90-25498* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
HAZARDS PROTECTION FOR SPACE SUITS AND SPACECRAFT Patent
JOSEPH J. KOSMO, inventor (to NASA) and FREDERIC S. DAWN, inventor (to NASA) 8 May 1990 9 p Filed 30 Jun. 1988 Supersedes N89-12206 (27 - 3, p 367)
(NASA-CASE-MSC-21366-1; US-PATENT-4,923,741; US-PATENT-APPL-SN-213880; US-PATENT-CLASS-428-252; US-PATENT-CLASS-428-290; US-PATENT-CLASS-428-328; US-PATENT-CLASS-428-422; US-PATENT-CLASS-428-447; US-PATENT-CLASS-428-458; US-PATENT-CLASS-428-474.4)
Avail: US Patent and Trademark Office CSCL 06/11

A flexible multi-layered covering article for protection against the hazards of exposure to the environment of outer space is disclosed. The covering includes an outer layer section comprising an outermost lamina of woven expanded tetrafluoroethylene yarns (Gore Tex) for protecting against abrasion and tearing, an underlying weave of meta-aramid yarns (Nomex) and para-aramid yarns (Kevlar) for particle impart protection, and electrostatic charge dissipation and control system incorporated therein, and a chemical contaminants control barrier applied as a coating. A middle section includes a succession of thermal insulating layers of polymeric thermoplastic or thermoforming material, each of which is coated with a metal deposit of high infra-red emissivity and low solar radiation absorption characteristics and separated from adjacent insulating layers by a low thermal conductance material. The covering further includes a radiation attenuating layer of a tungsten-loaded polymeric elastomer binder for protecting against bremsstrahlung radiation and an inner layer of rip-stop polyester material for abrasion protection. A chloroprene coating may be supplied the polyester-material for added micrometeroid protection. Securing means of low heat conductance material secures the multi-layers together as a laminar composite.
Official Gazette of the U.S. Patent and Trademark Office

N90-25499*# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
A GLOBAL APPROACH FOR USING KINEMATIC REDUNDANCY TO MINIMIZE BASE REACTIONS OF MANIPULATORS
C. L. CHUNG and S. DESA Mar. 1989 32 p
(Contract NAG3-811)
(NASA-CR-186825; NAS 1.26:186825; CMU-RI-TR-89-9)
Copyright Avail: NTIS HC A03/MF A01 CSCL 05/8

An important consideration in the use of manipulators in microgravity environments is the minimization of the base reactions, i.e. the magnitude of the force and the moment exerted by the manipulator on its base as it performs its tasks. One approach which was proposed and implemented is to use the redundant degree of freedom in a kinematically redundant manipulator to plan manipulator trajectories to minimize base reactions. A global approach was developed for minimizing the magnitude of the base reactions for kinematically redundant manipulators which integrates the Partitioned Jacobian method of redundancy resolution, a 4-3-4 joint-trajectory representation and the minimization of a cost function which is the time-integral of the magnitude of the base reactions. The global approach was also compared with a local approach developed earlier for the case of point-to-point motion of a three degree-of-freedom planar manipulator with one redundant degree-of-freedom. The results show that the global approach is more effective in reducing and smoothing the base force while the local approach is superior in reducing the base moment.
Author

N90-25500*# Alabama A & M Univ., Normal. Dept. of Plant and Soil Sciences.
A PROPOSAL TO DEMONSTRATE PRODUCTION OF SALAD CROPS IN THE SPACE STATION MOCKUP FACILITY WITH PARTICULAR ATTENTION TO SPACE, ENERGY, AND LABOR CONSTRAINTS Annual Progress Report, 1 Jul. - 30 Jun. 1990
CAROLYN A. BROOKS, GOVIND C. SHARMA, and CAULA A. BEYL 25 Jul. 1990 30 p
(Contract NCC2-607)
(NASA-CR-186811; NAS 1.26:186811) Avail: NTIS HC A03/MF A01 CSCL 06/11

A desire for fresh vegetables for consumption during long term space missions has been foreseen. To meet this need in a microgravity environment within the limited space and energy available on Space Station requires highly productive vegetable cultivars of short stature to optimize vegetable production per volume available. Special water and nutrient delivery systems must also be utilized. As a first step towards fresh vegetable production in the microgravity of Space Station, several soil-less capillary action media were evaluated for the ability to support growth of two root crops (radish and carrot) which are under consideration for inclusion in a semi-automated system for production of salad vegetables in a microgravity environment (Salad Machine). In addition, productivity of different cultivars of radish was evaluated as well as the effect of planting density and cultivar on carrot production and size. Red Prince radish was more productive than Cherry Belle and grew best on Jiffy Mix Plus. During greenhouse studies, vermiculite and rock wool supported radish growth to a lesser degree than Jiffy Mix Plus but more than Cellular Rooting Sponge. Comparison of three carrot cultivars (Planet, Short n Sweet, and Goldinhart) and three planting densities revealed that Short n Sweet planted at 25.6 sq cm/plant had the greatest root fresh weight per pot, the shortest mean top length, and intermediate values of root length and top fresh weight per pot. Red Prince radish and Short n Sweet carrot showed potential as productive cultivars for use in a Salad Machine. Results of experiments with solid capillary action media were disappointing. Further research must be done to identify a solid style capillary action media which can productively support growth of root crops such as carrot and radish. Author

N90-25501# Pennsylvania Univ., Philadelphia. Dept. of Computer and Information Science.
ACTIVE PERCEPTION AND EXPLORATORY ROBOTICS
RUZENA BAJCSY Oct. 1989 19 p Sponsored by DEC Corp., IBM Corp., and LORD Corp.
(Contract BOA-104230-87-H-0001; N00014-85-K-0807; NSF DCR-84-10771; F49620-85-K-0018; DAAG29-84-K-0061)
(MS-CIS-89-65; UP-GRASP-LAB-191) Avail: NTIS HC A03/MF A01

Active perception is defined as a problem of an intelligent data acquisition process. For this, one needs to define and measure parameters and errors from the scene which in turn can be fed back to control the data acquisition process. This is a difficult though important problem. The difficulty is that many of the feedback parameters are context-and scene-dependent. The precise definition of these parameters depends on a thorough understanding of the data acquisition devices (camera parameters, illumination and reflectance parameters), algorithms (edge detectors, region growers, 3-D recovery procedures) as well as the goal of the visual processing. The importance, however, of this understanding is that one does not spend time on processing and artificially improving imperfect data but rather on accepting imperfect, noisy data as a matter of fact and incorporating it into the overall processing strategy. The second point is that manipulation is an essential part of perceptual process. The hand is as the eye: a sensory device. Subsequently, one needs to consider not only signal processing modules but also basic manipulatory action called exploratory procedures as an essential ingredient of perceptual theory. The third and last point made is a case for exploratory robotics. It is assumed that the size and shape of the object is sufficient for grasping purposes. It should be very apparent that unless one knows what materials are being

used the system may be easily fooled. And even if the material of the outer surface is known the inside is not, which may very dramatically change the weight, and hence, the grasping strategy. The research aims to fill this gap. The question of rigidity is also very crucial when a grasping strategy is considered. Furthermore, the tests for hinges and bending are the first tests towards testing the functionality of an object. In the test for rigidity, what changes occur when other controlled manipulatory actions are applied on such objects, for example, lifting or rotating the object in space is explored. All these steps are part of a general examination of the object, finding stable positions, etc. All these tests lead to understanding of what the necessary components are for a general purpose Perceptual Theory. Author

N90-25514*# Air Force Systems Command, Wright-Patterson AFB, OH.

SDIO ROBOTICS IN SPACE APPLICATIONS

RICHARD ILIFF *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 133-136 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 05/8

Robotics in space supporting the Strategic Defense System (SDS) program is discussed. Ongoing initiatives which are intended to establish an initial Robotics in Space capability are addressed. This is specifically being referred to as the Satellite Servicing System (SSS). This system is based on the NASA Orbital Maneuvering Vehicle (OMV) with a Robotic Manipulator(s) based on the NASA Flight Telerobotic Servicer (FTS) and other SSS equipment required to do the satellite servicing work attached to the OMV. Specific Robotics in Space Requirements which have resulted from the completion of the Robotics Requirements Study Contract are addressed. Author

N90-25518*# Lockheed Engineering and Sciences Co., Houston, TX.

QUANTITATIVE ASSESSMENT OF HUMAN MOTION USING VIDEO MOTION ANALYSIS

JOHN D. PROBE *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 155-157 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 05/8

In the study of the dynamics and kinematics of the human body, a wide variety of technologies was developed. Photogrammetric techniques are well documented and are known to provide reliable positional data from recorded images. Often these techniques are used in conjunction with cinematography and videography for analysis of planar motion, and to a lesser degree three-dimensional motion. Cinematography has been the most widely used medium for movement analysis. Excessive operating costs and the lag time required for film development coupled with recent advances in video technology have allowed video based motion analysis systems to emerge as a cost effective method of collecting and analyzing human movement. The Anthropometric and Biomechanics Lab at Johnson Space Center utilizes the video based Ariel Performance Analysis System to develop data on shirt-sleeved and space-suited human performance in order to plan efficient on orbit intravehicular and extravehicular activities. The system is described. Author

N90-25522*# Stanford Univ., CA. Knowledge Systems Lab.

AN EXPERT SYSTEM TO ADVISE ASTRONAUTS DURING EXPERIMENTS: THE PROTOCOL MANAGER MODULE

GUIDO HAYMANN-HABER, SILVANO P. COLOMBANO, NICOLAS GROLEAU, DON ROSENTHAL, PETER SZOLOVITS, and LAURENCE R. YOUNG (Massachusetts Inst. of Tech., Cambridge.) *In* NASA, Lyndon B. Johnson Space Center, Third Annaul Workshop on Space Operations Automation and Robotics (SOAR 1989) p 187-194 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 05/8

Perhaps the scarcest resource for manned flight experiments - on Spacelab or on the Space Station Freedom - will continue to be crew time. To maximize the efficiency of the crew and to make use of their abilities to work as scientist collaborators as well as equipment operators, normally requires more training in a wide variety of disciplines than is practical. The successful application of on-board expert systems, as envisioned by the Principal Investigator in a Box program, should alleviate the training bottleneck and provide the astronaut with the guidance and coaching needed to permit him or her to operate an experiment according to the desires and knowledge of the PI, despite changes in conditions. The Protocol Manager module of the system is discussed. The Protocol Manager receives experiment data that has been summarized and categorized by the other modules. The Protocol Manager acts on the data in real-time, by employing expert system techniques. Its recommendations are based on heuristics provided by the Principal Investigator in charge of the experiment. This prototype was developed on a Macintosh II by employing CLIPS, a forward-chaining rule-based system, and HyperCard as an object-oriented user interface builder. Author

N90-25523*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM ADVANCED AUTOMATION PROJECT. PHASE 1: APPLICATION EVALUATION

BRANDON S. DEWBERRY *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 195-208 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 06/11

The Environmental Control and Life Support System (ECLSS) is a Freedom Station distributed system with inherent applicability to advanced automation primarily due to the comparatively large reaction times of its subsystem processes. This allows longer contemplation times in which to form a more intelligent control strategy and to detect or prevent faults. The objective of the ECLSS Advanced Automation Project is to reduce the flight and ground manpower needed to support the initial and evolutionary ECLS system. The approach is to search out and make apparent those processes in the baseline system which are in need of more automatic control and fault detection strategies, to influence the ECLSS design by suggesting software hooks and hardware scars which will allow easy adaptation to advanced algorithms, and to develop complex software prototypes which fit into the ECLSS software architecture and will be shown in an ECLSS hardware testbed to increase the autonomy of the system. Covered here are the preliminary investigation and evaluation process, aimed at searching the ECLSS for candidate functions for automation and providing a software hooks and hardware scars analysis. This analysis shows changes needed in the baselined system for easy accommodation of knowledge-based or other complex implementations which, when integrated in flight or ground sustaining engineering architectures, will produce a more autonomous and fault tolerant Environmental Control and Life Support System. Author

N90-25526*# Lockheed Engineering and Sciences Co., Houston, TX.

TELEPRESENCE FOR SPACE: THE STATE OF THE CONCEPT

RANDY L. SMITH, DOUGLAS J. GILLAN, and MARK A. STUART *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 223-228 Mar. 1990

Avail: NTIS HC A99/MF A04 CSCL 05/8

The purpose here is to examine the concept of telepresence critically. To accomplish this goal, first, the assumptions that underlie telepresence and its applications are examined, and second, the issues raised by that examination are discussed. Also, these assumptions and issues are used as a means of shifting the focus in telepresence from development to user-based research. The most basic assumption of telepresence is that the information being provided to the human must be displayed in a natural fashion, i.e., the information should be displayed to the same human sensory modalities, and in the same fashion, as if the person where actually at the remote site. A further fundamental assumption for the functional use of telepresence is that a sense of being present in the work environment will produce superior

performance. In other words, that sense of being there would allow the human operator of a distant machine to take greater advantage of his or her considerable perceptual, cognitive, and motor capabilities in the performance of a task than would more limited task-related feedback. Finally, a third fundamental assumption of functional telepresence is that the distant machine under the operator's control must substantially resemble a human in dexterity. Author

N90-25527*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TELEPRESENCE AND SPACE STATION FREEDOM WORKSTATION OPERATIONS
DEAN G. JENSEN, SUSAN C. ADAM, JAMES H. STRAMLER, and ROBERT P. WILMINGTON (Lockheed Engineering and Sciences Co., Houston, TX.) *In its* Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 229-234 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

The Space Station Freedom workstation system is a distributed network of computer based workstations that provides the man-machine interfaces for controlling space station systems. This includes control of external manipulator, robotic and free flyer devices by crewmembers in the space station's pressurized shirt-sleeve environment. These remotely controlled devices help minimize the requirement for costly crew extravehicular activity (EVA) time for such tasks as station assembly and payload support. Direct window views may be used for controlling some of the systems, but many activities will be remote or require levels of detail not possible by direct observation. Since controlling remote devices becomes more difficult when direct views are inadequate or unavailable, many performance enhancing techniques have been considered for representing information about remote activities to the operator. Described here are the telepresence techniques under consideration to support operations and training. This includes video enhancements (e.g., graphic and text overlays and stereo viewing), machine vision systems, remote activity animation, and force reflection representation. Author

N90-25528*# Bureau of Mines, Minneapolis, MN. Human Factors Group.
THE HUMAN FACTORS OF WORKSTATION TELEPRESENCE
THOMAS J. SMITH and KARL U. SMITH (Wisconsin Univ., Madison.) *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 235-250 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

The term workstation telepresence has been introduced to describe human-telerobot compliance, which enables the human operator to effectively project his/her body image and behavioral skills to control of the telerobot itself. Major human-factors considerations for establishing high fidelity workstation telepresence during human-telerobot operation are discussed. Telerobot workstation telepresence is defined by the proficiency and skill with which the operator is able to control sensory feedback from direct interaction with the workstation itself, and from workstation-mediated interaction with the telerobot. Numerous conditions influencing such control have been identified. This raises the question as to what specific factors most critically influence the realization of high fidelity workstation telepresence. The thesis advanced here is that perturbations in sensory feedback represent a major source of variability in human performance during interactive telerobot operation. Perturbed sensory feedback research over the past three decades has established that spatial transformations or temporal delays in sensory feedback engender substantial decrements in interactive task performance, which training does not completely overcome. A recently developed social cybernetic model of human-computer interaction can be used to guide this approach, based on computer-mediated tracking and control of sensory feedback. How the social cybernetic model can be employed for evaluating the various modes, patterns, and integrations of interpersonal, team, and human-computer interactions which play a central role is workstation telepresence are discussed. Author

N90-25537*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE FLIGHT TELEROBOTIC SERVICER (FTS) NASA'S FIRST OPERATIONAL ROBOTIC SYSTEM
J. ANDARY, K. HALTERMAN, D. HEWITT, and P. SABELHAUS *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 311-318 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

NASA has completed the preliminary definition phase of the Flight Telerobotic Servicer (FTS) and is now preparing to begin the detailed design and fabrication phase. The FTS will be designed and built by Martin Marietta Astronautics Group in Denver, CO, for the Goddard Space Flight Center, in support of the Space Station Freedom Program. The design concepts for the FTS are discussed, as well as operational scenarios for the assembly, maintenance, servicing and inspection tasks which are being considered for the FTS. The upcoming Development Test Flight (DTF-1) is the first of two shuttle test flights to test FTS operations in the environment of space and to demonstrate the FTS capabilities in performing tasks for Space Station Freedom. Operational planning for DTF-1 is discussed as well as development plans for the operational support of the FTS on the space station. Author

N90-25538*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE TELEROBOT TESTBED: AN ARCHITECTURE FOR REMOTE SERVICING
J. R. MATIJEVIC *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 321-328 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

The NASA/OAST Telerobot Testbed will reach its next increment in development by the end of FY-89. The testbed will have the capability for: force reflection in teleoperation, shared control, traded control, operator designate and relative update. These five capabilities will be shown in a module release and exchange operation using mockups of Orbital Replacement Units (ORU). This development of the testbed shows examples of the technologies needed for remote servicing, particularly under conditions of delay in transmissions to the servicing site. Here, the following topics are presented: the system architecture of the testbed which incorporates these telerobotic technologies for servicing, the implementation of the five capabilities and the operation of the ORU mockups. Author

N90-25555*# California Univ., Berkeley. Telerobotics Unit.
A HELMET MOUNTED DISPLAY TO ADAPT THE TELEROBOTIC ENVIRONMENT TO HUMAN VISION
GREGORY THARP, ANDREW LIU, HITOMI YAMASHITA, and LAWRENCE STARK *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 477-481 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

A Helmet Mounted Display system has been developed. It provides the capability to display stereo images with the viewpoint tied to subjects' head orientation. The type of display might be useful in a telerobotic environment provided the correct operating parameters are known. The effects of update frequency were tested using a 3D tracking task. The effects of blur were tested using both tracking and pick-and-place tasks. For both, researchers found that operator performance can be degraded if the correct parameters are not used. Researchers are also using the display to explore the use of head movements as part of gaze as subjects search their visual field for target objects. Author

N90-25556*# Carlow Associates, Inc., Fairfax, VA.
HUMAN FACTORS ISSUES IN TELEROBOTIC SYSTEMS FOR SPACE STATION FREEDOM SERVICING

THOMAS B. MALONE and KATHRYN E. PERMENTER *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 485-492 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

Requirements for Space Station Freedom servicing are described and the state-of-the-art for telerobotic system on-orbit servicing of spacecraft is defined. The projected requirements for the Space Station Flight Telerobotic Servicer (FTS) are identified. Finally, the human factors issues in telerobotic servicing are discussed. The human factors issues are basically three: the definition of the role of the human versus automation in system control; the identification of operator-device interface design requirements; and the requirements for development of an operator-machine interface simulation capability. Author

N90-25565*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE JPL TELEROBOT OPERATOR CONTROL STATION: OPERATIONAL EXPERIENCES
EDWIN P. KAN *In* NASA, Lyndon B. Johnson Space Center, Third Annual Workshop on Space Operations Automation and Robotics (SOAR 1989) p 567-575 Mar. 1990
Avail: NTIS HC A99/MF A04 CSCL 05/8

The Operator Control Station of the JPL/NASA Telerobot Demonstration System provides an efficient man-machine interface for the performance of telerobot tasks. Its hardware and software have been designed with high flexibility. It provides a feedback-rich interactive environment in which the Operator performs teleoperation tasks, robotic tasks, and telerobotic tasks with ease. The to-date operational experiences of this system, particularly related to the Object Designate Process and the Voice Input/Output Process are discussed. Author

N90-26490*# Florida Univ., Gainesville. Dept. of Aerospace Engineering, Mechanics and Engineering Science.
DESIGN OF SENSORS FOR CONTROL OF CLOSED LOOP LIFE SUPPORT SYSTEMS Final Report
Jul. 1990 7 p
(Contract NASW-4435)
(NASA-CR-186656; NAS 1.26:186656) Avail: NTIS HC A02/MF A01 CSCL 06/11

A brief summary is presented of a Engineering Design sequence, a cooperation between NASA-Kennedy and the University of Florida on the Controlled Environmental Life Support System (CELSS) program. Part of the class was devoted to learning general principles and techniques of design. The next portion of the class was devoted to learning to design, actually fabricating and testing small components and subsystems of a CELSS. E.R.

N90-26491 Department of the Navy, Washington, DC.
HELMET-MOUNTED HEAD RESTRAINT Patent
MICHAEL H. PATTERSON, inventor (to Navy) 20 Mar. 1990 4 p Filed 3 Nov. 1988 Supersedes N90-16394 (28 - 8, p 1105), AD-D014233
(AD-D014536; US-PATENT-4,909,459;
US-PATENT-APPL-SN-266955) Avail: US Patent and Trademark Office CSCL 05/8

This patent discloses a head restraint for the occupant of a vehicle seat. It restrains the forward and downward movement of the occupant's head when subjected to large deceleration forces. The restraint includes a strap assembly which encircles the back of the occupant's head and releasably connects to his helmet adjacent to each of his ears at two locations. A retaining strap is slidably connected by a loop to the strap assembly and extends behind the head to a retracting means fixed in the seat. The retracting means pulls the head back against the seat when the deceleration forces exceed a predetermined level, as during flight maneuvers. During normal flight conditions, the occupant is able to move his head freely from side to side as the strap assembly slides through the loop. GRA

N90-26492*# Georgia Inst. of Tech., Atlanta. Center for Man-Machine Systems Research.
PILOT INTERACTION WITH AUTOMATED AIRBORNE DECISION MAKING SYSTEMS Final Report
JOHN M. HAMMER 1990 57 p
(Contract NAG2-123)
(NASA-CR-186730; NAS 1.26:186730) Avail: NTIS HC A04/MF A01 CSCL 05/8

Ways in which computers can aid the decision making of an human operator of an aerospace system are investigated. The approach taken is to aid rather than replace the human operator, because operational experience has shown that humans can enhance the effectiveness of systems. As systems become more automated, the role of the operator has shifted to that of a manager and problem solver. This shift has created the research area of how to aid the human in this role. Published research in four areas is described. A discussion is presented of the DC-8 flight simulator at Georgia Tech. Author

N90-26493# Wichita State Univ., KS. Inst. for Aviation Research.
CHOOSING A PILOT SUBJECTIVE WORKLOAD SCALE TO FIT FLIGHT OPERATIONAL REQUIREMENTS
RANDALL M. CHAMBERS and KEVIN J. KILMER Oct. 1989 26 p
(IAR-89-21) Avail: NTIS HC A03/MF A01

The assessment of pilot and aircrew workload is vital to the success of flight operations. It is also important in the design of cockpit instrumentation, display and control subsystems, and flight tests, whether it be civilian or military. Currently, there are three different types of subjective assessment scales available for pilot subjective workload evaluations: (1) the Modified Cooper-Harper Scale; (2) the NASA TLX Scale; and (3) the Subjective Workload Assessment Technique (SWAT). Engineering design information and human factors data concerning the advantages and disadvantages of each scale is provided. Also, recommendations and constraints regarding the pilot's use of these scales in design, test, and operations are provided. Author

N90-26494# Wichita State Univ., KS. National Inst. for Aviation Research.
BIODYNAMIC SIMULATIONS OF AN AIRCRAFT PILOT/PASSENGER IN VARIOUS CRASH ENVIRONMENTS
HAMID LANKARANI, DEREN MA, and GAYLE ERMER May 1990 26 p
(NIAR-90-6) Avail: NTIS HC A03/MF A01

A simple multiple-segment model of the human body is developed in order to examine its dynamic response under the action of external forcing conditions. The system is modeled as a collection of rigid elements interconnected by an array of kinematic joints constraining the relative motion of the elements. These elements include upper body combined with head and neck, lower legs, and thighs. Nonlinear rotational springs are incorporated at the joints accounting for the anatomical characteristics and limits. The constructed model is used to simulate the post-crash behavior of an aircraft pilot or passenger during surges such as frontal/side collisions and crashes in the vertical plane. A mathematical representation of the seat and interaction of the passenger with the seat cushion and back is developed. Restraints representing the seatbelts are also introduced in the model in a few different configurations. The complete model is then subjected to various pulse accelerations or decelerations in different directions. To perform a dynamic analysis a 3-D code is developed that generates and numerically solves the governing differential equations of motion in a systematic fashion. This feature of generality allows future additions to the present simple model or construction of more advanced models in a convenient way. This computerized model and the results of the simulations provide a base for predicting the motion behavior of the human body parts during crashes, understanding the effects of various types of seats and seatbelts on passenger safety, and design of mechanisms for crash protection and cockpit/cabin interior elements. Author

N90-26495# Wichita State Univ., KS. National Inst. for Aviation Research.
HUMAN PERFORMANCE IN COCKPIT-RELATED SYSTEMS
RANDALL M. CHAMBERS and MIHRIBAN CIHANGIRLI May 1990 18 p
(NIAR-90-7) Avail: NTIS HC A03/MF A01

A complex cognitive assessment battery of computerized cognitive performance tests was installed in the cockpit of a flight simulator, and cognitive performance capabilities of thirty volunteer subjects were measured on nine cognitive tests. Research on the effects of cockpit-related conditions on cognitive performance indicated that performance capabilities were affected by the process of attending to and reading selected instruments in the cockpit. Aircraft noise of 90 dBA significantly increased subjective mental workload without altering cognitive performance significantly. Although there were many individual differences among the thirty volunteer test subjects, mean cognitive performance for the fifteen males was not significantly different from the mean cognitive performance of the fifteen females.
Author

N90-26496# Wichita State Univ., KS. National Inst. for Aviation Research.
HUMAN FACTORS: THE HUMAN INTERFACE WITH AIRCRAFT INTERIORS
RANDALL CHAMBERS, JEFFREY FERNANDEZ, SRIKANTH NANDIGAM, and VANKATESH PALANISWAMY Jun. 1990 29 p
(NIAR-90-18) Avail: NTIS HC A03/MF A01

The pilot, crew, and passengers interface with the aircraft's interior, its operational performance, its protective features and crash worthiness, its utilization during linear and angular accelerations and decelerations, and its management during crisis of a severe stress of impact and fire. Human factors considerations enter into the measurement and evaluation of crashworthiness performance, especially in the design criteria for seats, seat belts, shoulder harness, air bags, floors, and wall structures. Human factors considerations and design criteria also enter into the measurement and evaluation of performance, especially in crisis management and control, and performance of flight crew and passengers during fire, escape, depressurization, and other emergency situations. The human interface for protection in Gx accelerations and decelerations, and in Gy and Gz, have important design criteria for seats, back angle, shoulder straps and seat belts, dynamic and static supports, for head, neck, and torso. Body size and position for adults and for children require special considerations within acceleration fields produced within varying transportation systems. Subjective judgments of ride quality, comfort, and well-being are important in the human use of restraints and other interior protective components. Similarily, physiological indices and specific body distortions during deceleration, impact and burn provide important design criteria. Human use of controls and displays during emergency preparations and escape add specific design criteria and requirements for aircraft interior development.
Author

N90-26497*# Pennsylvania Univ., Philadelphia. Dept. of Computer and Information Science.
ASSEMBLY VIA DISASSEMBLY: A CASE IN MACHINE PERCEPTUAL DEVELOPMENT
RUZENA K. BAJCSY and CONSTANTINE J. TSIKOS Jan. 1989 12 p Sponsored in part by DEC Corp., IBM Corp. and LORD Corp.
(Contract NAG5-1045; F49620-85-K-0018; DAA29-84-K-0061; DAA29-84-9-0027; N00014-85-K-0807; NSF MCS-82-19196; NSF IRI-84-10413; NSF INT-85-14199; NSF DMC-85-17315; NATO-0224/85)
(NASA-CR-186867; NAS 1.26:186867; MS-CIS-89-04; GRASP-LAB-173) Avail: NTIS HC A03/MF A01 CSCL 05/8

First results in the effort of learning about representations of objects is presented. The questions attempted to be answered are: What is innate and what must be derived from the environment. The problem is casted in the framework of disassembly of an object into two parts.
Author

N90-26498*# Pennsylvania Univ., Philadelphia. Dept. of Computer and Information Science.
GRASPING WITH MECHANICAL INTELLIGENCE M.S. Thesis
NATHAN THATCHER ULRICH Dec. 1988 79 p
(Contract NAG5-1045; N00140-85-K-0807; NSF MEA-81-19884; NSF DCR-84-10771; NSF INT-85-14199; NSF DMC-85-17315; NSF DCR-82-19196)
(NASA-CR-186864; NAS 1.26:186864; MS-CIS-89-51; GRASP-LAB-190) Avail: NTIS HC A05/MF A01 CSCL 05/8

Many robotic hands have been designed and a number have been built. Because of the difficulty of controlling and using complex hands, which usually have nine or more degrees of freedom, the simple one- or two-degree-of-freedom gripper is still the most common robotic end effector. A new category of device is presented: a medium-complexity end effector. With three to five degrees of freedom, such a tool is much easier to control and use, as well as more economical, compact and lightweight than complex hands. In order to increase the versatility, it was necessary to identify grasping primitives and to implement them in the mechanism. In addition, power and enveloping grasps are stressed over fingertip and precision grasps. The design is based upon analysis of object apprehension types, requisite characteristics for active sensing, and a determination of necessary environmental interactions. Contained are the general concepts necessary to the design of a medium-complexity end effector, an analysis of typical performance, and a computer simulation of a grasp planning algorithm specific to this type of mechanism. Finally, some details concerning the UPenn Hand-a tool designed for the research laboratory-are presented.
Author

N90-26499*# Wisconsin Univ., Milwaukee. Space Architecture Design Group.
GENESIS LUNAR OUTPOST CRITERIA AND DESIGN
TIMOTHY HANSMANN, ed. & comp., GARY T. MOORE, ed. & comp., DINO J. BASCHIERA, JOE PAUL FIEBER, and JANIS HUEBNER MOTHS 11 Jun. 1990 119 p
(Contract NASW-4435)
(NASA-CR-186831; NAS 1.26:186831; R90-1; ISBN-0-938744-69-0) Avail: NTIS HC A06/MF A01 CSCL 05/8

This design study--the third in the space architecture series--focused on the requirements of an early stage lunar outpost. The driving assumptions of the scenario was that the base would serve as a research facility and technology testbed for future Mars missions, a habitat supporting 12 persons for durations of up to 20 months, and would sustain the following five experimental facilities: Lunar surface mining and production analysis facility, construction technology and materials testbed, closed environmental life support system (CELSS) test facility, lunar farside observatory, and human factors and environment-behavior research facility. Based upon the criteria set forth in a previous programming document, three preliminary lunar base designs were developed. Each of the three schemes studied a different construction method and configuration. The designs were then evaluated in terms of environmental response, human habitability, transportability, constructability, construction dependability and resilience, and their suitability in carrying out the desired scientific research. The positive points of each scheme were then further developed by the entire project team, resulting in one integrated lunar outpost design.
Author

N90-26500*# Kansas State Univ., Manhattan. Dept. of Mechanical Engineering.
AUTOMATION OF CLOSED ENVIRONMENTS IN SPACE FOR HUMAN COMFORT AND SAFETY Report, 1989-1990
1990 121 p
(Contract NGT-21-002-800)
(NASA-CR-186834; NAS 1.26:186834) Avail: NTIS HC A06/MF A01 CSCL 05/8

The results are presented of the first year of a three year project on the automation of the Environmental Control and Life

Support System (ECLSS) of the Space Station Freedom (SSF). The results are applicable to other future space mission. The work was done by the Kansas State University NASA/USRA interdisciplinary student design team. The six ECLSS subsystems and how they interact are discussed. Proposed control schemes and their rationale are discussed for the Atmosphere Revitalization (AR) subsystem. Finally, a description of the mathematical models for many components of the ECLSS control system is given. Author

N90-26501*# Idaho Univ., Moscow. Dept. of Mechanical Engineering.
GREENHOUSE DESIGN FOR A MARTIAN COLONY: STRUCTURAL, SOLAR COLLECTION AND LIGHT DISTRIBUTION SYSTEMS
1990 93 p
(Contract NGT-21-002-800)
(NASA-CR-186818; NAS 1.26:186818) Avail: NTIS HC A05/MF A01 CSCL 05/8

The inflatable structure serves as an ideal greenhouse while being feasible to transport and easy to assemble on Mars. Locating the structure underground protects it from the extreme environmental variations on the surface. The proposed lighting system provides all the necessary light for photosynthesis with little external power demand. These considerations make the proposed greenhouse design a viable means of providing an ongoing food supply for a Martian colony. Author

N90-26502# Norwegian Defence Research Establishment, Kjeller.
HUMAN PERFORMANCE MODELS
OIVIND SKARE 7 Feb. 1990 229 p In NORWEGIAN; ENGLISH summary
(FFI-90/7002; ISSN-0802-2437; ETN-90-97035) Avail: NTIS HC A11/MF A02

An overview of human performance models is given. The models are classified after Rasmussen's framework for characterizing various categories of behavior and after basic tasks which an operator is assumed to perform. The overview is concentrated on quantitative models and dynamic man machine systems. It is used on a command and weapon control system. Each activity in a weapon engagement is decomposed to a set of basic tasks. An experiment performed with chosen subjects is described. Different aspects with respect to how these subjects combine information are examined. ESA

N90-26503*# Maryland Univ., College Park. Inst. for Physical Science and Technology.
DEVELOPMENT OF EYE-SAFE LIDAR FOR AEROSOL MEASUREMENTS Final Report, 1988-1989
UPENDRA N. SINGH and THOMAS D. WILDERSON Aug. 1990 8 p
(Contract NAG5-1114)
(NASA-CR-186905; NAS 1.26:186905; BN-1114) Avail: NTIS HC A02/MF A01 CSCL 06/17

Research is summarized on the development of an eye safe Raman conversion system to carry out lidar measurements of aerosol and clouds from an airborne platform. Radiation is produced at the first Stokes wavelength of 1.54 micron in the eye safe infrared, when methane is used as the Raman-active medium, the pump source being a Nd:YAG laser at 1.064 micron. Results are presented for an experimental study of the dependence of the 1.54 micron first Stokes radiation on the focusing geometry, methane gas pressure, and pump energy. The specific new technique developed for optimizing the first Stokes generation involves retroreflecting the backward-generated first Stokes light back into the Raman cell as a seed Stokes beam which is then amplified in the temporal tail of the pump beam. Almost 20 percent conversion to 1.54 micron is obtained. Complete, assembled hardware for the Raman conversion system was delivered to the Goddard Space Flight Center for a successful GLOBE flight (1989) to measure aerosol backscatter around the Pacific basin. Author

N90-26504# Syracuse Univ., NY. Dept. of Chemical Engineering and Materials Science.
DEVELOPMENT OF MEMBRANE PROCESS FOR CARBON DIOXIDE SEPARATION FROM DIVING ATMOSPHERE
S. A. STERN and K. A. LOKHANDNALA May 1990 84 p
(AD-A222606; NCSC-CR-20C-1-90) Avail: NTIS HC A05/MF A01 CSCL 13/10

Computer simulations show that membrane separation processes can be used effectively to remove Carbon dioxide 2 from exhaled air in an underwater breathing apparatus. Membrane separation processes are based on the selective permeation of the components of a gas mixture through nonporous polymer membranes. A permeator module provided with membranes in the form of asymmetric or composite hollow fibers is best suited for CO2 removal from exhaled air. The operation of such a permeator, designed to reduce the CO2 concentration in exhaled air from about 4 to 1 mole-percent, was simulated in order to determine its optimum dimensions and membrane are requirement. The exhaled air will flow in such a permeator in an axial direction inside the hollow fibers, while the external surface of the fibers will be in contact with sea water. The fraction of the exhaled air permeating through the hollow fibers (the permeate) will be enriched in CO2, which will be dissipated in the sea water. GRA

N90-26505# Krug International, San Antonio, TX. Technology Services Div.
AIRCREW LIFE SUPPORT SYSTEMS ENHANCEMENT Final Report, 1 Aug. 1985 - 30 Apr. 1989
ROBERT W. KRUTZ, JR., THOMAS E. NESTHUS, WILLIAM R. SCOTT, JAMES T. WEBB, CHERIE J. NOLES, JANET F. WIEGMAN, ROSALIND A. CHAVEZ, and BIJAN ESHAGHIAN Feb. 1990 108 p
(Contract F33615-85-C-4503; AF PROJ. 7930)
(AD-A222626; USAFSAM-TR-89-26) Avail: NTIS HC A06/MF A01 CSCL 06/5

This final report is a summary of the contract objectives and accomplishments; it includes a complete bibliography of reports generated for the Crew Technology Division. The scientific, engineering, and technical team from KRUG International provided support in accordance with task assignments developed from the statement of work as summarized in each of the 11 areas discussed in this report. Each summary is followed by a review of the accomplishments with reference, where appropriate, to the appendix which lists publications documenting the work completed. GRA

N90-26506# Naval Postgraduate School, Monterey, CA.
MOTION SICKNESS, VISUAL DISPLAYS, AND ARMORED VEHICLE DESIGN Contractor Report, Oct. 1988 - Sep. 1989
Apr. 1990 129 p Proceedings of a Conference on Wraparound Visual Displays, Waltham, MA 14-15 Jan. 1988
(AD-A222678; BRL-CR-629) Avail: NTIS HC A07/MF A01 CSCL 06/10

The report analyzes the operational requirements of low-profile armored vehicles and the underlying causes of motion sickness symptoms arising from conflicting visual vestibular cues. The report identifies some of the probable determinants of motion sickness symptoms and recommends profitable directions for further research on this topic. GRA

N90-26507# Illinois Univ., Urbana-Champaign.
PSYCHOPHYSIOLOGICAL ASSESSMENT OF PILOT WORKLOAD IN AN APPLIED SETTING M.S. Thesis
JOHN STEVEN BELL 1990 139 p Sponsored by AFIT, Wright-Patterson AFB, OH
(AD-A222707; AD-E501236; AFIT/CI/CIA-90-026) Avail: NTIS HC A07/MF A01 CSCL 05/8

One of the greatest problems facing researchers, design teams, and practitioners of engineering psychology is to determine that the product of their labors, whether a new type of computer interface or a new concept cockpit in a next generation aircraft, places demands upon the operator that are consistent with the known limits of human performance capacities. It is one thing to

have a machine that performs a task with great efficiency. It is quite another to place a human operator at the controls of this machine and obtain ideal performance efficiency levels. Engineers are most concerned that the machine they have constructed is functionally capable of performing the operations it was designed for and sustaining its function within some specified lifetime. The machine's functional parameters are easily tested and relatively well understood. GRA

N90-26508# North Carolina Univ., Chapel Hill. Dept. of Computer Science.
A REAL-TIME OPTICAL 3D TRACKER FOR HEAD-MOUNTED DISPLAY SYSTEMS
JIH-FANG WANG, VERNON CHI, and HENRY FUCHS Mar. 1990 11 p
(Contract N00014-86-K-0680; NIH-RR-02170)
(AD-A222747) Avail: NTIS HC A03/MF A01 CSCL 17/11

A new optical system for real-time, three-dimensional position tracking is described. This system adopts and inside-out tracking paradigm. The working environment is a room where the ceiling is lined with a regular pattern of infrared LEDs flashing under the systems's control. Three cameras are mounted on a helmet which the user wears. Each camera uses a lateral effect photodiode as the recording surface. The 2-D positions of the LED images inside the field of view of the cameras are detected and reported in real time. The measured 2-D image positions and the known 3-D positions of the LEDs are used to compute the position and orientation of the camera assembly in space. We have designed an iterative algorithm to estimate the 3-D position of the camera assembly in space. The algorithms is a generalized version of the Church's method, and allows for multiple cameras with nonconvergent nodal points. Several equations are formulated to predict the system's error analytically. The requirements of accuracy, speed, adequate working volume, light weight and small size of the tracker are also addressed. GRA

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SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

A90-43385* Cornell Univ., Ithaca, NY.
COMETARY DELIVERY OF ORGANIC MOLECULES TO THE EARLY EARTH
CHRISTOPHER F. CHYBA, PAUL J. THOMAS, CARL SAGAN (Cornell University, Ithaca, NY), and LEIGH BROOKSHAW (Yale University, New Haven, CT) Science (ISSN 0036-8075), vol. 249, July 27, 1990, p. 366-373. Research supported by Kenneth T. and Eileen L. Norris Foundation. refs
(Contract NGR-33-010-220; NGR-33-010-101; NGT-50302; NAGW-1023; N00014-83-K-0610)
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It has long been speculated that earth accreted prebiotic organic molecules important for the origins of life from impacts of carbonaceous asteroids and comets during the period of heavy bombardment 4.5 x 10 to the 9th to 3.8 x 10 to the 9th years ago. A comprehensive treatment of comet-asteroid interaction with the atmosphere, surface impact, and resulting organic pyrolysis demonstrates that organics will not survive impacts at velocities greater than about 10 kilometers per second and that even comets and asteroids as small as 100 meters in radius cannot be aerobraked to below this velocity in 1-bar atmospheres. However, for plausible dense (10-bar carbon dioxide) early atmospheres, it is found that 4.5 x 10 to the 9th years ago earth was accreting intact cometary organics at a rate of at least about 10 to the 6th to 10 to the 7th kilograms per year, a flux that thereafter declined with a half-life of about 10 to the 8th years. These results may be put in context by comparison with terrestrial oceanic and total biomasses, about 3 x 10 to the 12th kilograms and about 6 x 10 to the 14th kilograms, respectively. Author

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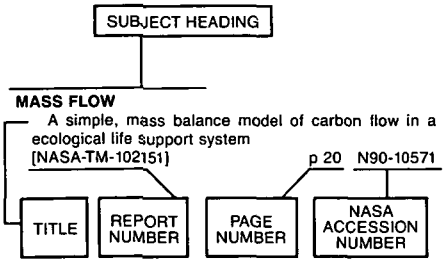

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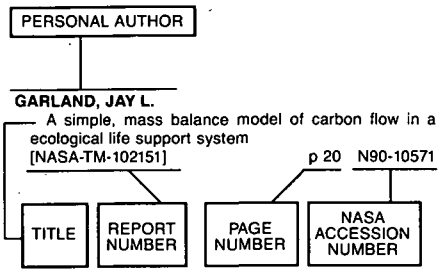

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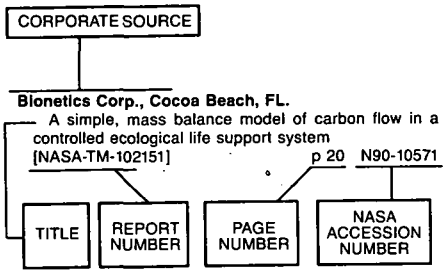

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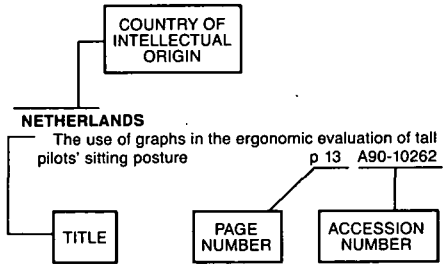

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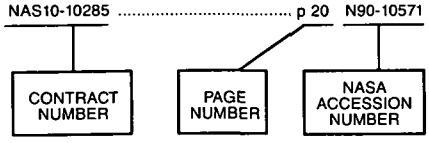

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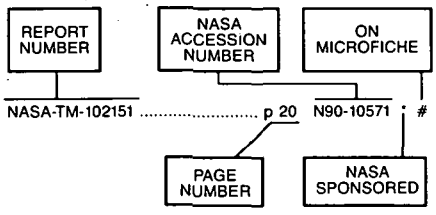

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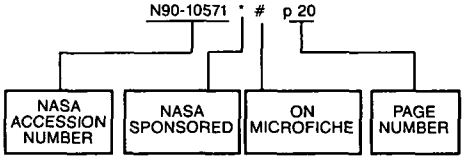

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7011(342)		

4. Title and Subtitle	5. Report Date
Aerospace Medicine and Biology A Continuing Bibliography (Supplement 342)	November 1990
	6. Performing Organization Code NTT
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address NASA Scientific and Technical Information Division	11. Contract or Grant No.
	13. Type of Report and Period Covered Special Publication
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This bibliography lists 208 reports, articles and other documents introduced into the NASA scientific and technical information system in October 1990.

17. Key Words (Suggested by Authors(s))	18. Distribution Statement
Aerospace Medicine Bibliographies Biological Effects	Unclassified - Unlimited Subject Category - 52

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price *
Unclassified	Unclassified	84	A05/HC

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NASA-Langley, 1990

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